ADDIS ABABA UNIVERSITY

COLLEGE OF NATURAL AND COMPUTATIONAL SCIENCES

SCHOOL OF INFORMATION SCIENCE

READINESS ASSESSMENT FOR IMPLEMENTING E-VOTING SYSTEM IN ETHIOPIA: A GAP ANALYSIS FROM SUPPLY SIDE

By

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ADDIS ABABA, ETHIOPIA

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A Thesis Submitted to School of Graduate Studies of Addis Ababa University in Partial Fulfillment of the Requirements for the Degree of Master of Science in Information Science and Systems (Information Systems Specialization)

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Declaration

This thesis has not previously been accepted for any degree and is not being concurrently submitted in candidature for any degree in any university.

I declare that this thesis entitled “READINESS ASSESSMENT FOR IMPLEMENTING E-VOTING SYSTEM IN ETHIOPIA: A GAP ANALYSIS FROM SUPPLY SIDE” is a result of my investigation, except where otherwise stated. I have undertaken the study independently with the guidance and support of my research advisor. Other sources are acknowledged by citations giving explicit references. A list of references is appended.

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This thesis has been submitted for examination with my approval as a university advisor.

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Abstract

Extant literature revealed that elections conducted in traditional ways mostly result in crises and conflicts. Intending to address such challenges, it has been a few decades since countries have begun using e-voting technology as an electoral system to conduct a transparent election. Countries that used e-voting technology have managed the political, social, and economic instability and crisis that arise from election fraud. However, the application of this new system encountered different challenges due to a lack of readiness to exploit its value, especially in developing countries context. Thus, it is vital to support the electoral system through technology to make the election result credible to citizens and political parties. The readiness of government, citizens, and political parties need to be assessed before using e-voting as an electoral system.

The main purpose of this study is to assess the gaps in the readiness of the country for e-voting system implementation. The researcher has employed a qualitative research method to explore the factors that affect the readiness of e-voting technology in Ethiopia. The qualitative data were collected through in-depth interviews and document reviews to identify the gaps. Thematic analysis was used to analyze the data.

The finding revealed that the country is not ready in terms of ICT infrastructure, human resources, and legality measures for e-voting technology. There is no adequate ICT infrastructure for e-voting system implementation throughout the country. There is also a lack of qualified human resources, a lack of budget, and the inexistence of legal structure. Finally, recommendations for the readiness of e-voting system implementation were proposed.

Keywords: electronic-voting system, e-voting readiness, e-readiness

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List of Acronyms

AEC	Australian Electoral Commission
BGAN	Broadband Global Area Network
DRE	Direct Record Electronic
DREVM	Direct Recording Electronic Voting Machine
EBP	Electronic Ballot Printers
E-democracy	Electronic Democracy
E-Government	Electronic Government
EML	Election Mark-up Language
EVM	Electronic Voting Machine
E-Voting	Electronic Voting
EVS	Electronic Voting System
EVACS	Electronic Voting and Counting System
FAQ	Frequently Asked Questions
FDRE	Federal Democratic Republic Of Ethiopia
IDEA	International Institute for Democracy and Electoral Assistance
ICT	Information Communication Technology
IT	Information Technology
I-Voting	Internet-Voting
LAN	Local Area Network
LCD	Liquid Crystal Display
MCIT	Ministry of Communication and Information Technology
MInT	Ministry of Innovation and Technology
NEBE	National Election Board of Ethiopia
OMR	Optical Mark Recognition
PBVS	Paper Ballot-Voting System
PEVS	Poll-site Electronic Voting Systems

PCOS	Precinct Count Optical Scanning
PKI	Public Key Infrastructure
REVS	Remote Electronic Voting Systems
SMART	Simple, Moral, Accountable, Responsive and Transparent
U.S.	United State
VPN	Virtual Private Network
VVPAT	Voter-verified Paper Audit Trail

CHAPTER ONE

INTRODUCTION

This chapter is to introduce the background of the research, statement of the problem, research questions, and the objectives of the research. Moreover, the chapter describes the significance and scope of the research.

1.1 Background of the Study

Democratic voting is very important for a nation because it provides an opportunity for people to vote their opinion and vote for what they believe in, it holds elected officials accountable for their behavior while in office, and it prevents a minority from dictating the policies of majority. The perceptions of society play an important role to establish a democratic government. The societies express their perception through voting so the voting should be reliable, accurate, and transparent. Among the various systems of an election, the paper-based election system is the most dominating in many countries of the world. Now a time technological advancement provides an opportunity for countries of the world to use ICTs in the government and democratic processes, among the process electronic voting is the one, which uses technological devices, such as stand-alone or movable voting machines, to cast votes. Electronics voting system is a voting system that registers, stores, and manages the election results mainly as digital content (Gritzalis, 2003).

IDEA (2011) define the e-voting system as a voting system, which uses information and communication technologies to record, cast, and count votes in political elections and referendums. Electronic voting can be thought of as a better form of voting, for eliminating the drawbacks of the paper-voting system. Even though the e-voting technology plays an important role in the reduction of the problems of the paper-based voting system, its implementation is affected by several factors such as human resources, technology, and legal structure.

Ethiopia's current voting system is a paper-based voting system that brings with it many issues, such as delay in voting results, labor, cost, lack of opportunity to disable citizens and citizens living outside the country, electoral fraud, and electoral influence in the polls.

Nwogbaga and Ogbu (2015) state the challenges of the traditional paper ballot voting system of election as:

- Logistical and transportation challenges: traditional paper ballot elections require the movement of people and voting materials to the polling station and collation center for the casting of ballots and counting of results. Transporting election results by traditional means of transportation exposes outcomes to multiple threats, such as an attack by democratic losers and aggrieved party members. Such constraints have an adverse impact on the reliability of traditional ballot systems and challenge the need for its continued adoption.

- Inadequate transparent mechanism: another major problem of a paper-based voting system is the lack of consistency in the processes of counting and collating. Manually' election officials collate, count, and report the result of elections. The system is also vulnerable to the danger of human error and deliberate manipulation. The susceptibility to the manipulation of the manual method of voting enables electoral officials with dishonest intention and their accomplices easily manipulate election unnoticed at all stages of the election. Also, the manual method allows for simultaneous voting, voting by non-eligible persons, coercion of voters, and alteration of counted ballots before the declaration, and manipulation of result during the long period between the closure of polls and the declaration of results. E-election promotes accountability as it enables the authorities to count the votes from the moment that election begins; counting on receipts with barcodes which is re-election a feature of increases the accountability level for elections.

- Security challenges: Security is another issue of a paper-based voting system. Where life and property are at risk in the traditional elections, voter turnout, and apathy will be small. Personal security of election personnel, candidates, media members, observers, and voters is paramount in elections integrity. E-voting systems are more, secure than paper ballot voting systems of an election but threats may exist, which might be lead to internal and external intrusion and fraud. Talab & Ameen (2013) states the potentials threats of the e-voting system as a denial of service, viruses, ping of death, worms, and physical attack.

According to statistics from the NEBE, a first nationwide election was held under the provision of the current constitution in June 1994 to elect members of local government. A general election has since been held in 1995, 2000, 2005, 2010 and 2015, yet the public reaction to those six election results was rigged, which result in the death of many citizens in opposition to some polls. These concerns arise from the fact that voters do not have trust in the election result of the paper-based voting system.

According to the Amnesty International Report (2015) among the problems of the Ethiopian election that resulted in the paper-based voting system was lack of trust of the conservative parties that was mainly due to the delay of the official election results being announced. Also, some of the ruling party's leaders would notice the stealing of the votes of opposition parties by intimidating observers and opposition party members at some polling station. These concerns are the main initiator for assessing the readiness of Ethiopia to implement the e-voting system.

Rubin (2004) stated that elections require the citizen to choose the people they consider fit to serve. Naturally, the honesty of the political decision process is fundamental to the trustworthiness of democracy itself. He further claimed that any system designed for election must be a system capable withstanding any attack, and must also be a system that the electorate can embrace and that the different candidates can accept the election results without any dispute. However, elections are most frequently manipulated to influence their outcome.

The electronic election is a solution to overcome such and similar problem and to update the country's electoral system and make the election credible to the public and the opposition parties.

In this research, the researcher sought to assess the readiness of the supply side for the implementation of the e-voting system in Ethiopia, identify factors that affect the readiness of e-voting systems such as ICT infrastructure, the legal framework, and human resources.

1.2 Statement of the Problem

A free and fair election is a reflection of the civilization of a nation, and its role in highlighting the country's image is not easy, in fact, that many countries of the world could not exercise it. Now a time countries like Namibia and Brazil are identifying and implementing e-voting systems to make their election process credible. E-voting system is a voting system that uses electronic means to either aid or takes care of casting and counting votes. Electronic voting systems for electorates have been in use since 1960 G.C.

The two main types of e-voting are e-voting which is physically supervised by the government and remote e-voting via the internet where the voter submits their votes electronically to election authorities. There are also various types of e-voting systems, ranging from computer-based voting stations to paper-based systems such as optical scanning systems, punch cards, mechanical lever machines, and remote e-voting systems, all of which allow the voters to use electronic tools and processes to cast, transfer and count votes (Frankland & Volkamer, 2011). E-voting system may use a standalone electronic voting machine or computer connected to the internet. It uses a range of internet services from the transmission of results to online voting through connected household devices.

Lubis (2018) said the social structure, human resources, and ICT infrastructure of the country should be considered before adopting the e-voting system. There are also nine significant substances related to the previous adoption from other countries, including internet vulnerabilities, democracy drawbacks, e-voting unconstitutionality, privacy, and confidentiality confusion, technology insecurity, fraud proneness, adverse experience, technical preparation, and hacker ability (Ardiyanti, 2016). According to Rogers (1995), technological acceptance improvement has been affected by factors such as societal context, social norm, leader perception, and agent of transition.

It is important to thoroughly analyze and know the ICT infrastructural readiness of the country, the approval of the leader, the legal framework, and the human resource skill to ensure that the viability of the e-voting system in Ethiopia. ICT infrastructure readiness reflects the level of networked infrastructures, technology skills, technology use, and access to technology (ITU, 2018). Before implementing the e-voting system, the security aspect must be considered.

Data-monitor (2008) states the benefits of proper implementation of the e-voting system as reduced costs, increased participation and voting options, increased speed of voting, the accuracy of voting and counting votes, increased accessibility and flexibility for voters with disabilities.

This research assesses the readiness to implement the e-voting system in Ethiopia from the supply side such as the readiness of IT infrastructure, human resources, and legal framework. According to Mokodir (2011) the technology infrastructure, legal structures, security, perceived ease of use, reliability, trust, and awareness are determinants that influence e-voting system readiness.

1.3 Research Questions

The following are the main research questions of this study:

1. How ready is Ethiopia to adopt the e-voting system from the supply side?
2. What are the possible gaps for the successful implementation of e-voting systems?

1.4 Objective of the Study

1.4.1 General Objective

The general objective of the study is to identify gaps in the readiness of Ethiopia for implementing e-voting system from the supply side.

1.4.2 Specific Objective

The specific objectives of this study are:

- To review the literature and understand the concept of e-voting readiness;
- To assess the ICT infrastructure of the country for successful implementation of e-voting system;
- To identify the gaps in the readiness of human resource ;
- To identify the existence of a legal framework for e-voting technology.

1.5 Scope of the Study

Because of time constraints, the study mainly focuses on assessing the readiness of the government for the implementation of an e-voting system; it does not assess the readiness of society and political parties. The study does not include the design and implementation of an e-voting system.

1.6 Significance of the Study

The study is significant for various reasons; the finding will provide information about the country's capacity of implementing an e-voting system for different governmental bodies especially for the Ministry of Innovation and Technology and Ethio Telecom regarding ICT infrastructure. If the telecom infrastructure of the country is not enough to implement the e-voting system, the government of Ethiopia is expected to perform additional works. It also provides information for political parties on the gaps in e-voting implementation.

Investigating the readiness of implementing the e-voting system guides the NEBE for further implementation. Government election executives also get to understand the factors that affect e-voting system readiness. The research explores potential barriers to the implementation of the e-voting system from the supply side. The result of this study will contribute to on-going researches in this domain area.

1.7 Organization of the Thesis

The thesis has five Chapters. The first chapter about introductory concepts such as the background of the study, statement of the problem, research questions, objectives of the study, scope of the study, and significance of the study. The literature review part of the thesis is dealt in chapter two in which discussion is conducted on the concept of e-government, e-democracy, e-voting system, benefits of an e-voting system, features and functionality of e-voting technology, developed and developing countries experience of e-voting technology, requirements of e-voting technology and factors affecting e-voting system implementation. Chapter three is entirely dedicated to the discussion of research methodology i.e. data collection and analysis methods. Presentation, analysis, and discussion of the data follow in Chapter four. The last Chapter five is conclusions and recommendations.

CHAPTER TWO

LITERATURE REVIEW

2.1 Introduction

In this chapter, different related pieces of literature from different parts of the globe were review. The researcher strongly finds related literature that helps to understand the concept of e-voting systems using different search parameters. The following are among the concepts, which are discussed here: an overview of electronic government, electronic democracy, definition, and types of e-voting systems, benefits of an e-voting system, features, and functionalities of e-voting technology, other countries experience of e-voting system implementation, a requirement of e-voting system implementation, and factor affecting e-voting system implementation. Moreover, related works of this research also reviewed in this chapter.

2.2 Electronic Government

Following the increased pace of electronic transformation, several e-concepts related to the usage of ICT emerged to cover numerous aspects of the on-going changes in the public sector. It includes e-democracy, e-participation, e-voting, e-administration, e-citizen, and e-readiness (Makarava, 2011).

Countries of the world start using technological innovation to boost their economy and social service and to improve their political environment. E-government is one of the technological innovations, which are exercised by many countries of the world. The term e-government emerged in the late 1990s, but the history of computing government organizations can be traced back to the beginnings of computer history (Grönlund and Horan, 2004). Although e-government is a recent occurrence, that plays an important role in economic development. Different definitions and theories are explaining the idea of e-government. Osborne and Gaebler (1992) defined e-government as the government's use of technology, in particular, web-based internet applications to enhance access and delivery of government services to citizens, business partners, employees, and other government entities.

World Bank (2012) defined e-government as:

The use by government agencies of information technologies (such as Wide Area Networks, the Internet, and mobile computing) that can transform relations with citizens, businesses, and other arms of government. These technologies can serve a variety of different ends: better delivery of government services to citizens, improved interactions with business and industry, citizen empowerment through access to information, or more efficient government management.

Fang (2002) divides E-government types (models) into eight: Government-to-Citizens (G2C), Citizens-to-Government (C2G), Government-to-Business (G2B), Business-to-Government (B2G), Government-to-Government (G2G), Government-to-Non-Profit (G2N), Non-Profit-to-Government (N2G) and Government-to-Employees (G2E). Properly designed and implemented, e-government can improve efficiency in the delivery of government services, simplify compliance with government regulations, strengthen citizen participation, and trust in government, and yield cost savings for citizens, businesses, and the government itself (Ntulo and Otike**,** 2013).

Seifert & Bonham (2003) states the benefits of e-government as follows:

Cheaper: a website can be a very cost-effective way to exchange information, both for its owner and for its users. It reduces the number of inquiries organization staff has to deal with, by providing answers to the most common questions or queries (also known as FAQs, Frequently Asked Questions) it normally receives and therefore reduces the amount of staff effort and cost needed to respond to them. Websites also represent a cheaper alternative to the production and dissemination of printed materials like leaflets, letters, and so on.

Quicker: web publishing is immediate which allows the fast release of news and other information items to the public, which an organization may find useful too, say respond to promptings from the media, or act in moments of crisis. Websites provide information 24 hours a day, 7 days a week, and can, therefore, cater to the parts of the population either that find it hard to visit the organization in person (including, for instance, the disabled) or to contact it during working hours.

E-Government provides social benefits for the citizens of a country. For countries that have a widely dispersed population, and e-government service allows the citizens situated in remote areas to have access to the same services that citizens within the major cities would enjoy. It can also provide better ways to manage information compared to traditional means.

To build a transparent and accountable government system and to increase citizen participation, the government of Ethiopia started uses e-government activities. Ethiopian Ministry of Communication and Information Technology (MCIT), currently called MInT (2011 G.C), prepares the e-government strategy for Ethiopia, which is design, with a focus on facilitating effective delivery of government services to customers (residents, businesses, and visitors). The e-government strategy that was approved in 2011 envisages the implementation of 219 e-services comprising of 79 informational and 140 transactional services over five years. Implementation is proposed through 12 priority projects and service delivery would be through four primary channels Portals, Call centers, Mobile devices, and Common service centers. The e-government service delivery will be facilitated and strengthened through six core projects including The National Payment Gateway, The Enterprise Architecture Framework, The Public Key Infrastructure, The National Data Set, The National Enterprise Service Bus, and The National Integrated Authentication Framework. Based on the strategy, MCIT has launched more than 28 transactional services extracted from the Ministry of Agriculture (MoA), Ministry of Foreign Affairs (MoFA), Ministry of Urban Development and Construction (MUDC), Food, Medicine and Health Care Administration and Control Authority (FMHACA), Agency for Government Houses (AGH), and Transport Authority on this portal.

Demeke (2014) states that citizens and businesses get benefits from e-government activities that are launched by MCIT as:

- People request public services by filling out electronic forms and attaching scanned versions of all necessary supporting documents from anywhere and anytime.
- People can also track the status of their requests using unique service request tracking numbers arrange appointments with the service providing government organizations when physical presence is required; get periodic notifications through email and SMS, and provide their feedback for future improvements.

According to 2014 report of United Nation Department of Economics and Social Affairs, based on E-Government Development Index (EGDI), the three components of the E-Government Development Index (EGDI) are: OSI-Online Service Index, TII-Telecommunication Infrastructure Index, HCI-Human Capital Index, Ethiopia received (between 0.25 and 0.50) which is a middle-level EGDI point. In terms of the OSI-Online Service Index, which is one of the most important components of the EGDI, Ethiopia received 0.4567 and was ranked 72nd among 183 nations around the world.

2.2.1 Electronic Democracy (E-democracy) s

Greece is the birthplace of democracy; the word "democracy" emerged in Athens in the 5th century BC. The modern English word "democracy" originated from ancient Greek "demokratia," which means "people's rule or governance." Democracy is a system of government in which people choose their rulers by voting for them in elections. Democracy provides several benefits for different countries of the world for a long time, but due to technology development, many countries observed that updating their democratic system. The term e-democracy is deceptive, it comes as one of many names (Tele-democracy, IT-democracy, etc.), which is usually, and vaguely, meant information and communication technology applied to enhance public participation in democratic processes (Grönlund, 2002). E-democracy (electronic democracy, also known as digital democracy) refers to the use of information technologies, communication technologies, and strategies in political and governance processes (Liu, 2012). E-democracy concerns all sectors of democracy, all democratic institutions, and all levels of government.

E-democracy cannot be isolated from traditional democratic processes. It is additional, complementary to, and interlinked with traditional democratic processes, to widen the choices available to the public for taking part in political processes (EPACE, 2009). E-democracy is a new mode of political participation people may express their political will through the Internet, as electronic voting and electronic forums. E-democracy has two main objectives: the first one is to provide citizens with the accessibility to information and knowledge about the political process, services, and choices available: and the second one is to make possible the transition from passive information access to active citizen participation (Shanab, Knight, and Refai, 2010). E-democracy fails within e-government categories, most under government-to-citizens (G2C) (Bhatnagar, 2004).

2.2.2 Electronic-Voting (E-voting)

Transparent and ethical voting is significant for the overall nation's development. Countries that do not engage transparent voting are exposed to different social, political, and economic problems, beyond that their citizens are subject to various forms of persecution, and mistreatment, even death. Eulau, Gibbins, and Webb (2015) define voting as the formal process of selecting a person for public office or of accepting or rejecting a political proposition. Voting is the central institution of democratic representative governments, since in a democracy; the authority of the government derives solely from the consent of the governed. The principal mechanism for translating that consent into governmental authority is holding transparent voting. Democratic elections are not merely symbolic. They are competitive, periodic, inclusive, definitive elections in which citizens who enjoy broad freedom to criticize the government, to publish their criticism, and to present alternatives, select the chief decision-makers in a government.

As stated in the Ethiopian Electoral and Political Parties Proclamation general elections, local elections, by-elections, re-elections, and referendum conducted in the country following the FDRE and regional constitutions, and other relevant laws.

General elections: the elections held every five years to elect members of the House of Peoples' Representatives and Regional State councils.

Local Elections: the elections held to elect a representative to zonal, woreda, city municipality, and sub-city or Kebele councils conducted following relevant laws.

By-election: is an election held in a single political constituency to fill a vacancy arising during a government's term of office.

Re-Election: is a rerun of an election on the order of the Ethiopian National Electoral Board as per the authority is given to it by Proclamation No 1133/2019; on the order of the Federal Supreme Court; or when the election candidates received the equal number of votes and were tied for the seat.

Referendum: voting by the electorate on a particular proposal presented to it following the FDRE Constitution or other relevant laws.

Government and Election Board take responsibility to ensure that the election held in the country is free, transparent, and fair. Without secure, fair, and transparent elections, there is neither the possibility for citizens to express their will nor the opportunity for citizens to change their leaders, approve policies for the country, address wrongs, or protest the limitation of their rights. Conducting free and fair elections is a major problem in most developing countries, they experience issues like ballot box snatching, coercion, and violence because of insufficient security measures put in place. These fraudulent occurrences can easily weaken the confidence of the voter and support the democratic system (Anyanwu, 2012). The term "electronic voting" depicts the use of some electronic means or machinery that is more or less computer supported in voting and ensures better security, reliability, and transparency (Hossain, Shakur, Ahmed, and Paul, 2012).

E-voting is one of the platforms of e-government that has various approaches and models that contribute to the theory and practice of e-democracy. Collord (2013) describe e-voting as a fully-electronic means of capturing and counting ballots for an election. Many people of the world choose their leader and political parties through voting, it does not mean that their voting process is no blemish. It is common to observe that fraud in the election result, even in developed countries, even though e-voting doesn't completely solve the problem of voting fraud, but it provides a possible mechanism to reduce voting fraud through its proper implementation.

2.3 Electronic Voting Systems

A voting system is a set of rules that tells how election and referendums are conducted, and how their outcomes are decided. Voting systems are the tools used by the eligible citizens to vote freely among different options (Nogueira and Sá-Soares, 2012). A voting system also encompasses other things like procedures, operating manuals, supplies, printouts, and other software necessary for the system's operation (Lee, 2019). Gritzalis (2003) classified a voting system as paper-ballot voting and electronic voting. Among the types of voting systems, Ethiopia uses paper-ballot voting systems.

Coleman and Fischer (2003) defined Paper-Ballots voting system as follows:

The paper-ballot voting system is the most common and classical method of voting. In this system, the candidate lists along with their respective parties are placed in a ballot paper. Voters mark their choices on the ballot. Each voter gets one paper. The vote-counting system

is manual. All voting technologies using document ballots use paper or cardstock, but the term paper ballot generally refers to those that are designed to be read by humans rather than machines.

According to the report of the NEBE, the following are some of the challenges of paper-ballot voting systems of Ethiopia:

- The inefficiency of the manual voting system, time and the resources wasted during the voting.
- The ineffectiveness of the electoral process and that of thousands of polling station officials.
- Also, an electoral environment where there is little or no trust of the independent NEBE.

IDEA (2011) classified the e-voting system as Poll-site electronic voting systems (PEVS) and remote electronic voting systems (REVS). In a poll-site electronic voting system, the voting process can be performed in a pre-defined and controlled environment by the electoral commission. While the remote electronic voting systems do not require the presence of the voter in pre-defined voting places: the vote can be cast from anywhere using the internet as a medium of communication between the system and the voter. The direct record electronic voting system, optical scanning system, and punch card are under the PEVS, while internet voting (i-voting) is in the REVS.

• DRE Systems: DRE systems allow voters to mark their votes directly through an electronic device with a touch screen, pushbuttons, or a similar tool. DRE systems require voting to be registered directly. Vote data are stored on a computer hard disk, CD-ROM, or smart card by the electronic device. DRE systems can come with or without a paper trail (VVPAT, or voter-verified paper audit trail). VVPATs are intended to provide physical evidence of the votes cast.

• Optical Scanning Systems: An optical scanning device combines specialized computer hardware and software. The hardware records an image and software transforms the image into data that is readable by the machine. Voting cards with the names of candidates written thereon shall be given to voters using machine-readable ballots. Next to each candidate a symbol is printed, such as a rectangle, circle, or incomplete arrow. The voter indicates a choice for a candidate by filling in the appropriate rectangle or circle or by completing the arrow.

• Punch Cards: With punch card systems, voters punch holes in cards using a supplied punch device, to indicate votes for their chosen candidates. After voting, the voter may feed the card directly into a computer vote-tabulating device at the polling place, or the voter may place the card in a ballot box, which is later transported to a central location for tabulation.

• Internet Voting Systems: where votes are transferred via the Internet to a central counting server. Votes can be cast either from public computers or from voting kiosks in polling stations or more commonly from any Internet-connected computer accessible to a voter.

2.4 Motivations of an E-voting System

E-election is often seen as a tool for advancing democracy, building trust in discretionary administration, adding believability to election results, and increasing the general proficiency of the appointive procedure. E-voting system is the quickest, cheapest, and most efficient way to administer election and count vote since it only consists of a simple process or procedure and requires a few workers within the process. E-voting system should provide all basic features that conventional voting does, further should furnish more services to make the process more trusted and secure (Ameen and Talab, 2012).

The following are the motivation of the e-voting system according to IDEA (2011).

- The faster vote count, tabulation, and more accurate results as human error are excluded
- Efficient handling of muddled appointive systems formulae that require laborious counting procedures
- Potentially expanded participation and turnout, especially with the utilization of Internet voting
- More sensitive to the needs of an increasingly mobile society
- Prevention of extortion in polling stations and during the transmission and organization of results by reducing human intervention
- Increased accessibility, for example by audio ballot papers for blind voters, with Internet-voting as well for housebound voters and voters from abroad
- Possibility of multilingual UIs that can serve a multilingual electorate better than paper ballots

- Cost savings by utilizing Internet voting, worldwide reach with very little logistical overhead. No shipment costs, no postponements in conveying material, and receiving it back.

2.5 Risks and Benefits of E-voting

To overcome the problems of traditional paper ballot voting systems e-voting system is crucial since it provides a solution for problems like a voter-verifiable audit trail, multiple voting, over-voting, security, and confidentiality.

Vries and Bokslag (2016) state the risks and benefits of e-voting system as follows:

Benefits of e-voting:

Fast counting: Counting can be done in mere minutes, compared to a paper-based voting system that takes hours and sometimes days, depending on the country.

Less labor-intensive: Although e-voting systems still require polling stations, no additional labor is needed for counting.

Cheaper: A benefit that is often mentioned is that electronic voting will cost less. **Accessibility**: It is argued that e-voting is more accessible than paper-voting for the visually impaired. They can bring headphones and the buttons can be given tactile feedback. On the other hand, for the elderly, e-voting may be more difficult than paper voting.

Further improved accessibility: With I-voting, there is no need to go to a polling station. It is more accessible for the physically impaired. It might reduce the number of people that vote by proxy. Electronic voting has the potential benefits to reduce or remove unwanted human errors. Furthermore; e-voting can handle multiple modalities, and provide better scalability for large elections.

Equipo Civiciti (2019) describes the benefits of voting over the internet as:

Increasing the level of participation –

The Internet voting system tends to maximize user participation, by allowing them to vote from anywhere and allowing access from different computer systems and from any device, which has an internet connection.

Security -

In electronic voting processes, in addition to logical and physical protection layers, mechanisms are established to ensure that only users accredited by an official document participate so that all security guarantees are provided that equate the electronic voting process with a classic electoral process.

Auditability -

In e-voting technology, the whole voting process is auditable end to end. The design of the system allows administrators to guarantee users that their votes are correctly issued and accounted for according to the intention to vote. Besides, a voting receipt is issued for each user.

Efficiency -

The reduction in organizational and implementation costs significantly increases the efficiency of election management compared to traditional paper voting.

Precision -

The electronic vote eliminates errors in the manual count, which brings with it an accurate and quick publication of results, with receipt of the vote for each vote cast.

Drawbacks of e-voting:

Scalability of attacks: It is easier to do large-scale attacks because often the same systems and software are being used across a country. To influence paper-voting counts, an attacker will have to manipulate many different polling stations. This also brings us to the number of people committing fraud: for e-voting fraud, one or a small group of attackers may be able to change the outcome of an election, while when considering paper elections, in general, a larger group is needed.

Less transparency: The e-voting process is a lot less transparent, especially for non-technical people. Advanced knowledge of cryptography is required for people to be able to prove that their vote was taken into account in the election results and that all the votes were counted correctly. Only a small amount of researchers will comprehend this, while the rest of the population will have to trust a system they cannot understand.

Additional drawbacks of I-voting:

Usage on untrusted and unmanaged client systems -

I-voting solutions generally assume that the client systems can be trusted. This assumption does not hold since many home computers are unsafe.

Coercion resistance is very difficult if not impossible to achieve –

The benefit of voting in a polling station is that the voter goes into the polling booth alone, and does not leave with tangible evidence of the casting vote. If someone attempts to coerce a voter into voting for a certain candidate, there is no way the voter can be expected to prove to him or her whom he voted for. This does not hold for i-voting. Someone can be forced to vote while others are watching; one can be forced to record confirmation of their vote.

2.6 Features and Functionalities of E-voting Technology

Electronic voting systems have many functions, including encryption, randomization, communication, and security systems. IDEA (2011) states the features and functionalities of e-voting systems as follows:

- **Electronic voter lists and voter authentication:** Part of an electronic voting system can be an electronic voter list, covering either a single polling station or the entire country. This list can be used to authenticate eligible voters and to record that they have cast their votes.

- **Poll worker interfaces:** Special functionalities that are only available to poll workers, for example, resetting the vote count at the opening of the polling station, closing polling, printing, and transmission of results.

- **Interfaces for casting vote:** These include touch screens, optical mark recognition (OMR) ballot papers that are fed into a scanner, touch-sensitive tablets, pushbuttons, web pages, or special client software for Internet voting.

- **Special interfaces for handicapped voters:** These include Braille or audio input devices for the blind, easier access for voters with physical disabilities, and simpler interfaces for illiterate voters.

- **Interfaces for the results output:** For voting machines, this is often a printer. However, some machines only use digital displays. Once voting is closed this interface can be used to display or print the results that were recorded by the voting machine. If results are printed the printouts can be used as physical evidence of the results produced by the voting machine, and copies can be distributed to stakeholders present at the polling station and can be posted for public display.

- **Result transmission system:** Many voting machines can transmit results to central counting systems, for example via the Internet, telephone, mobile phone, or satellite connection. In the absence of communication links, the results can also be transported physically, using electronic storage media such as memory cards.

- **Result tabulation systems, usually located at the result-processing center:** At the end of Election Day, they receive electronic results from polling stations and automatically tabulate the results for the various competitions and districts.

- **Result publication systems:** Preliminary and final results can be published in many different ways including on websites, CDs, and geographic visualization systems, and if required on all levels of detail down to single polling stations. The more detailed the published results are, the more transparent the election.

- **Confirmation code systems:** Some e-voting solutions allow for control codes that are intended to allow individual verification of each vote by the relevant voter.

2.7 Other Countries Experience of the E-voting System

2.7.1 Developed Countries Experience of the E-voting System

2.7.1.1 The Belgium Experience

The use of electronic voting in Belgium first began in 1991 during its federal elections, making it one of the first countries in the world to adopt e-voting (Cock and Preneel, 2007). There were several reasons why Belgium brought an e-voting system. These included the seeking of quicker results announcements, cost savings, and easier administration (Esteve, Goldsmith, and Turner, 2012). Under the e-voting system of Belgium before 2003, the voter would select their voting preferences on a machine using a light pen. The vote, rather than being stored in the machine itself, is written on the magnetic stripe of a card. The voter then takes this card and places it into an electronic ballot box. The box then reads the magnetic stripe of the card and records the vote stored on it. Once the voting process is finished, the electronic ballot boxes write the results to a floppy disk, which is then transported to the cantonal headquarters (Cock and Preneel, 2007).

In 2003, a new e-voting system was introduced to try to convince citizens that the system was safe. In the two locations that originally started e-voting, a "Ticketing" system was introduced. The principle of this is to add a printer next to the voting machine (magnetic card and light pen), and a paper copy of the vote is printed and approved by the voter. Once the elections are finished, all the paper votes (tickets) are counted and compared to the electronic result. The paper count and the electronic count matched nowhere, and it was decided (against the law) to favor the electronic result, which was considered more reliable. The law to organize this new test stated explicitly that this was for one election only.

Figure 2- 1: Belgium Voter Ballot

Problems of Belgium E-voting systems

Kleijn (2007) states the following problems in the e-voting systems of Belgium that are used in the 2003 federal elections:

- Problems of security of the encryption keys, Leaking of sensitive information, Lack of defensive secure code practices.
- The voting system was also found to be vulnerable to a limited replay attack.
- Being a PC based system makes it very venerable to manipulation and fraud.
- Moderate reliability errors reported in each election (impossible result, long delays).
- Very complex rules set intended to limit fraud, those complex rules are not understood by the poll workers and politicians.
- Safe and accountability are not verified, ordinary peoples.
- The cost is three times higher than traditional paper voting i.e. in 2003 an E-vote cost of 4.5 Euro was recorded per vote. The paper vote was 1.5 Euro.

2.7.1.2 The Australia experiences

The Australian Electoral Commission (AEC) manages national elections, whereas state or territory electoral commissions manage elections specific to their state or territory. Electronic voting in Australia was used for the first time in October 2001 in an Australian parliamentary election, in the Australian Capital Territory (ACT) (Buckland and Wen, 2012). This followed a close election in 1998 in the territory during which numerous flaws were found in the hand counting system. This led to the adoption of an e-voting system called EVACS, which stands for Electronic Voting and Counting System (Kumar and Walia, 2011). Significantly, the EVACS system is Linux-based and open source. The source code is available to the public allows for a greater level of trust in the system.

Despite the introduction of e-voting in the ACT in 2001, it was some years until other states in the country followed suit. There have been local and remote e-voting trials since then throughout the country, both at the national level and at the state level (Buckland and Wen, 2012). The federal government of Australia also introduced online voting for national elections. A trial took place during the 2007 federal election, which was limited to members of the Australian Defence Force (ADF) who were serving in various locations, including Iraq and Afghanistan.

Remote Internet-voting process

According to the Technical Report, U.S. Election Assistance Commission, 2011 the following processes are undertaken in the Internet-voting systems of Australia.

i. Members of the Australian Defence Force who were lives in Iraq and Afghanistan had successfully registered to use the system;
ii. A personal identification number (PIN) and voting instructions were sent to them via mail;
iii. To cast a vote, a voter would log in on the Defence Restricted Network (DRN) and enter the relevant information;
iv. Voting was then done through a Java applet executing in the voter's browser;
v. A receipt was then issued to the voter, once their votes had been cast successfully.

Challenges faced by Australia I-voting systems

Small numbers of problems were experienced with the i-voting system, such as:

- There was an unexplained minute outage of the system during voting.
- The number of votes printed did not match the number of votes contained in the decrypted voting file. This was due to a JavaScript failure that some voters experienced and affected some ballots.

2.7.2 Developing Countries Experience of the E-voting System

2.7.2.1 The Brazil Experience

Brazil, one of the most important developing countries and a member of the BRICS has adopted electronic voting in 1996. Lheureux, Freitas, and Macadar (2006) states that in Brazil, the electronic voting process has developed and improved constantly in terms of hardware, software, interface, efficiency, and security. Over the last twenty-six years, the Electoral Court has added voters' biometric data as additional information on voter identification. In the Brazilian e-voting system, the vote is only virtual, in other words, the vote is not printed. Brazil uses the electronic ballot box as an e-voting machine. An electronic Ballot box is a microcomputer customized for the electoral process. It is a standalone machine without any kind of internet connection and it comprises two terminals connected: the voter’s terminal and the voting terminal. Both terminals have numerical keypads. The machine has an internal battery that may be used in case of electricity problems.

The voting process

The e-voting process encompasses the following steps:

i. Voter identification: president of the poll station types the electoral ID number of the voter in the voter's terminal or the voter places his/her finger on the fingerprint reader in the same terminal;
ii. Electronic ballot box identifies the voter's record in the database machine;
iii. The voter can vote to type his/her candidate's number in the voting terminal in an isolated environment (no one can see his/her vote);
iv. The display shows candidates;
v. Voter presses the button CONFIRMA (confirm in Portuguese) and the vote is done or press button CORRIGE (redress) in case of mistake and restarts again.

Since the voting process finishes, the counting process starts:

i. The president of the poll station finishes the voting process by typing a password in the voter's terminal;
ii. The voting terminal prints a document with the polling results of that specific electronic ballot box;
iii. The data of polling results are encrypted and loaded in the USB stick;
iv. The USB stick is sent to the Electoral Counting Center;
v. The data is loaded to the Electoral Counting Center and then transmitted to the Electoral Court net;
vi. Electoral Court displays the polling results.

Challenges faced by Brazilian E-voting System

Even though the Superior Electoral Court of Brazil says that the electronic voting process has essential mechanisms to ensure the safety of the citizens, scholars and Information Technology experts disagree this idea and pointing out weaknesses of the electronic voting system as:

Lack of Auditability: Without the material representation of the vote, (electronic ballot box does not print the ballot) it is impossible to audit electoral results.

Secrecy of the vote: the system would block any attempt to identify the voter's ballot.

Costs: Brazilian people do not know the costs related to e-voting and in what way e-voting expenditures can affect or impact important social programs. It is a Market-driven approach rather than a socially driven technology strategy.

Lack of transparency: focus on blocking of external attack and lack of concern about risks of internal attack and; all Brazilian electronic ballot boxes use the same cryptographic key.

2.7.2.2 The Philippines Experience

O'Meara (2013) stated that the Philippines first began considering the adoption of electronic voting in 1993 due to fears of corruption in the electoral system. Although the Philippines does not use an electronic voting system for the election carried out within the country due to problems of logistics and security, until 2010. A pilot project did take place in 2008 in the Autonomous Region in Muslim Mindanao. This pilot used a combination of Direct Recording Electronic (DRE) and Optical Mark Recognition (OMR) technologies.

The success of this pilot allowed for the national implementation of electronic voting in the 2010 elections. However due to a lack of public trust in DRE systems and concerns about costs and reliability, DRE technology was not used in the election, only Optical Mark Recognition technology was used.

Figure 2- 2: Philippines Voting Machine

The Voting process: Goldsmith and Ruthrauff (2012) state the process of Philippines OMR voting system as:

i. After authentication voters were issued a secrecy folder and paper ballot, upon which they used a pen to shade an oval to mark each of their choices;
ii. After completing the ballot, the voter inserted it into the feeder slot of the OMR-based precinct count optic scan (PCOS) machine. If the PCOS accepted the ballot, the machine display flashed a confirmation message;
iii. PCOS scanned the ballot and saved the image as a TIFF file in the compact flash card, along with data on how the PCOS read the ballot choices. The paper ballot dropped into a secure box under the scanner;
iv. After casting their ballots, voters returned to the Board of Election Inspectors (BEI) to have their finger marked with indelible ink;

v. In the end, data from the PCOS machines were electronically transmitted to the municipal, national, and central consolidation centers immediately after closure of the polls using two transmission methods: cellular transmission through general packet radio service on the global system for mobile communications (GSM); and satellite transmission through Broadband Global Area Network (BGAN). Although the transmission was, in general, fast and efficient, there were reports of transmission failures or the inability of the consolidation centers to receive data.

Challenges faced by the Philippines E-voting System

The Philippines encounter the following problems in the electronic voting systems, which were used in the 2010 election, the problems are included:

- The voting machines provide a feature for verifying voter choice registration, but on Election Day, this feature was disabled. The machines were equipped with screens that would display how a voter's ballot had been read by the software. The reason given for disabling this feature is that it would slow down the voting process.
- The machines were used in the election of 2010 was not producing the right results based on the ballots they had processed. This, it turned out, was due to a printing error on the ballots. One side of the ballots had, correctly, been printed in single spacing. However, the other side of the ballots had been designed in double spacing. This caused the machines to be unable to read the ballots and therefore could not correctly determine the voters' intentions.

2.7.2.3 The Namibian Experience

As stated in the report of Electoral Institutes for Sustainable Democracy in Africa (EISA) (2014) Namibia became the first African country to conduct a national election using electronic voting. The introduction of electronic voting into the Namibian elections first started being discussed in 2004. With the challenges faced in the counting and tabulation processes in the 2009 elections, the use of DREVMs found its way into the 2009 Electoral Act. Because of this, the Electoral Commission of Namibia (ECN) began purchasing batches of Indian-manufactured DREVMs. These DREVMs are independent machines and are not connected to any computer network. They do not transmit or receive any signal, therefore cannot be intercepted. Batteries, along these lines conceivable to work in regions with no power for the whole length of the election process, likewise power DREVMs.

The DREVMs used by Namibia for the 2014 general election, have one Ballot Unit in one voting booth for the presidential election (nine candidates), and two Ballot Units in tandem in another voting booth for the legislative election (sixteen parties). The Control Unit is the control section of the DREVMs and only a polling official operates it. This unit controls the polling process. The Control Unit consists of four sections: the display screen, the candidate set, the results button, and the ballot button. The Ballot Unit is the voter interface and voters only interact with this unit and not the Control Unit. It consists of an interconnecting cable, which connects the Ballot Unit to the Control Unit, ready lamp buttons, one register lamp button, slide switch window, and 15 candidate buttons.

Figure 2- 3: Electronic Voting Machine used by Namibian 2014 general election (Ballot Unit on the left and Tabulator on the right)

The Voting process:

i. Verification of voter identity against the voter registers by polling workers;
ii. Polling workers also check a voter if he/she has voted before by verifying the fingers of indelible ink;
iii. The voter presses a green button corresponding to the political party or candidate of his or her choice on the Ballot Unit;
iv. The voter then has to press the red Register button on the Ballot Unit to complete the voting process;
v. At the end of polling, closing and counting procedures in the polling stations were strictly followed, and all DREVMs control units produced aggregated results that were accepted by all election agents;
vi. Finally, the result was announced at each polling station, the control units were taken to the constituency results centers where they were then plugged into the Tabulators to aggregate all the polling stations results for further transmission to the national results center.

Challenges faced by Namibian EVMs System

Even though the 2014 election of Namibia, which is supported by DREVMs, is achieving its objectives but some inconsistencies are to be expected when systems are used for the first time. Some of the problems are:

- **Accuracy**: Given that Namibian DREVMs so far have no Voter-Verified Paper Audit Trail (VVPAT) capability, the only assurance that DREVMs record and aggregate votes accurately is the pre-poll test. Where the VVPAT is intended as a verification system designed to allow voters to verify that their vote was cast correctly, to detect possible election fraud, and to provide a means to audit.

- **Breakdowns and technical support:** There were a few cases of DREVMs breakdowns that were reported by observers. In all those instances, technical support from the ECN was swift and managed to resolve the problem without any major impact on the voting process. Most breakdowns at the polling stations happened concerning the voter identification machines.

- **Voter-friendless:** Except voters who had voted in the few local or by-elections before the general elections, this was the first time the overwhelming majority of voters operated a DREVMs. On average voters took more seconds with each DREVM to make their choice and cast their vote. There were many reported cases of unsure voters, about which buttons are pressed and in which order.

2.8 Requirements for E-voting System Implementation

Council of Europe (2005) states the e-voting technology requirement as a legal requirement, technical requirements, and procedural requirement. These three categories of requirements all include provisions concerning all stages of elections and referendums (i.e. the pre-voting stage, the actual casting of votes, and the post-voting stage).

2.8.1 Legal Requirement

The legal requirement relates to the legal context in which the e-voting system is permitted.

Universal suffrage

- The e-voting system's voter interface shall be understandable and easily usable.
- To the degree practicable, the e-voting system shall be intended to expand the open doors that such systems can offer people with disabilities.

Equal suffrage

- The arrangement of e-voting shall keep any voter from choosing more than one voting channel.
- Any vote set in an electronic ballot box shall be checked, and each vote cast in the political election or referendum will be counted only once.

Free suffrage

- The e-voting organization shall secure for the free arrangement and perception of the voter's opinion and, where required, the personal exercise of the right to vote.
- The e-voting system shall not require the exercising of any manipulative influence of the voter during the voting.

Secret suffrage

- The e-voting system shall ensure that votes in the electronic polling booth and votes being tallied, and will remain, mysterious and that it is not possible to reconstruct a connection between the vote and the voter.
- The e-voting technique is intended to avoid the estimated number of votes in any electronic ballot box from associating the outcomes to actual voting.

2.8.2 Technical Requirements

The technical requirements related to the construction and operation of electronic voting equipment and software. The adoption of technical requirements will ensure the accessibility, interoperability, and security of e-voting systems.

Accessibility

- Measures shall be taken to ensure that all electors have access to the appropriate software and services and, where possible, to alternate forms of voting.
- Users shall engage in the design of e-voting systems, in particular in defining restrictions and checking the ease of use at each key stage of the development.

Interoperability

- Common standards shall be used to ensure interoperability between the different technological elements or resources of an e-voting system, likely originating from several sources.
- The Election Mark-up Language (EML) format is such an open standard and EML is used wherever possible for e-election and e-referendum applications to guarantee interoperability.

Security

(Security requirements are viewed in terms of pre-voting, voting, and post-voting stages)

I Requirements in pre-voting stages

- Concerning data sharing, the reliability, accuracy, and credibility of voter registries and candidate lists shall be protected during the pre-voting periods. The data source must be validated. Provisions on data protection shall be respected.

II Requirements in the voting stages

- The confidentiality of data exchanged from the pre-voting period (e.g. voters' registers and lists of candidates) shall be retained as regards data exchange during the voting stages. Authentication of the sources of the data shall be carried out.

- The e-voting system shall first ensure that a user who tries to vote is eligible to vote. The e-voting system shall authenticate the voter and shall ensure that only the appropriate number of votes per voter is cast and stored in the electronic ballot box.

III Requirements in post-voting stages

- The integrity of data communicated during the voting stage (e.g. votes, voters' registers, lists of candidates) shall be maintained. Data-origin authentication shall be carried out.
- The counting process shall accurately count the votes. The counting of votes shall be reproducible.

2.8.3 Procedural Requirement

The Procedural requirement relates to how e-voting hardware and software should be operated and maintained.

Transparency

- Information concerning the activity of an e-voting system will be made accessible to general society.
- Voters shall have the opportunity to exercise every new method of e-voting at the time of electronic voting before and apart from it.

Verifiability and accountability

- The parts of the e-voting system shall be unveiled, in any event to the equipped constituent specialists, as required for confirmation and accreditation purposes.
- There shall be the possibility for a recount. Other features of the e-voting system that may influence the accuracy of the outcomes will be irrefutable.

Reliability and security

- The e-voting system shall contain measures to safeguard the accessibility of its administrations during the e-voting procedure. It shall oppose, specifically, glitch, breakdowns, or denial of service attacks.
- The e-voting system shall maintain the accessibility and honesty of the votes. It shall also maintain the confidentiality of the votes and keep them sealed until the counting process. If stored outside controlled environments, the votes will be encoded.

2.9 Factors Affecting E-voting System Implementation

Proper implementation of e-voting systems can speed up the voting process in the sense that voters will not have to go to an election official to stamp their ballot paper. E-voting will also increase the security and reliability of elections and also reduce and simplify the work of authorities significantly and will lead to cost-saving through the reduction of electoral officers and personnel at a particular polling station.

Even though the proper implementation of e-voting systems provides the above and more advantages, its implementation is affected by several factors. Social structure, human resources, and ICT infrastructure are important factors that should be considered before the implementation of e-voting technology (Lubis, Kartiwi, and Durachmanuthors, 2018).

Achieng and Ruhode (2013) describe the factors that affect the implementation of e-voting systems as ICT resources and infrastructures, the usefulness of the technology, ease of use, trust in the technology, and environment.

2.9.1 ICT Resource and Infrastructure

The provision of ICT resources and infrastructure to facilitate the implementation of any innovation is significant and could influence the adoption of technology in this case e-voting. Lack of ICT infrastructure and resources would hinder the adoption of the e-voting system. As stated in the report of the Ethiopian Information and Communication Technology Development Agency (2016) Government of Ethiopia will adopt appropriate mechanisms to facilitate universal access to affordable ICT-based broadband services, with particular attention to children, women, and persons with disabilities.

ICT is essential for empowering people all over the world. It provides knowledge and information, which is essential for the success of democracy. Ethiopia has achieved some growth and development in the ICT sector for the last twenty years. As indicated in the report of ETC (2018), fifty-three million people use cell phones in Ethiopia. However, it is still far behind several African countries. It is one of the countries with very low Internet penetration.

Every year ITU analyzes the growth and development of ICT services across the world. Based on this analysis, ITU ranks the ICT services of the countries. This is quantified as the ICT development index (IDI). According to the report of ITU in 2018, Ethiopia is ranked at 170 out of 176 countries for which IDI ranks are available in 2017. Even neighboring countries like Kenya, Djibouti, and Sudan are ahead of Ethiopia in IDI.

The development of ICT in Ethiopia is at a low stage. ITU (2018) states the reasons for the low level of ICT development in the country as:

- Lack of skilled human resources coupled with low ICT literacy,
- Low level of Internet service and poor connectivity,
- Lack of organized data and information resources and poor accessibility to those that exist,
- Limited or no public awareness on the role and potential of ICT,
- The undeveloped private sector,
- Legal and regulatory constraints.

2.9.2 The Usefulness of E-voting Technologies

Electronic-voting technologies have many advantages such as the convenience of access, timesaving, expense (transportation), and the effort needed to vote. E-voting will minimize human error in the electoral process and improve election efficiency. Such a technology would keep voters from experiencing nerve-wracking circumstances such as holding up long queues at voting stations, terrorizing from party specialists, and many more.

2.9.3 Ease of Use

When potential adopters view a system as being difficult to use and understand. Particularly among elderly citizens who do not know such a technology, the electronic voting system will be difficult to use or understand.

E-voting may be difficult to use for the illiterate people of the informal settlement who have not had previous knowledge or experience with this technology.

2.9.4 Trust in the Innovation

Technology trust is a feasible factor that could have an impact on the implementation of electronic voting. Protection and privacy concerns were considerations that could impede trust and thus the implementation of electronic voting technologies. If e-voting were not sufficiently protected, citizens' right to vote could be under attack, and hackers could modify or manipulate their voting information.

2.9.5 Environment

The environment in which potential innovation is to be introduced could have an impact on the adoption of this technology. The government considers the political environment and the citizens' environment before deciding on the implementation of electronic voting technology. Whether or not these two environments accept technology is crucial to the implementation of electronic voting.

2.10 Related Empirical Works

Author (year)	Objectives	Methodology	Key Finding
Fouad JF Shat and Pamela Abbott, (2016)	Investigating the factors, which affect the implementation of e-voting system in Palestinian	Qualitative research methodologies have been used for determining the factors that affect the success and likelihood of the implementation of e-voting services in Palestine	Implementation of e-voting is a complex phenomenon and is affected by political, cultural, and organizational factors.
Nikhil L.Kshemkalyani and Viraj A.Bandekar, (2016)	To develop an online voting system for the people of the country residing around the world	Rational unified process method has been used to develop the online voting system	Design a new system with face recognition and fingerprint detection
Shafi'i Muhammad Abdulhamid, Olawale Surajudeen Adebayo, and Abdulmalik Danlami Mohammed, (2013)	To develop an electronic voting system, which will eliminate rigging and manipulation of results to its barest minimum for Nigeria Independent Election Commission	To design the system unified modeling language (UML) have been used and to write source code PHP, MySQL, Java Query, CSS, and HTML were used	Security Features Built-in e-voting System was developed
Muharman Lubis, Mira Kartiwi, and Yusuf Durachmanuthors, (2018)	To assess the privacy protection, and the readiness of electronic voting of Indonesia through citizen perspective, and expert view	Both quantitative and qualitative research methods were used	Social structure, human resources, and ICT infrastructure are important factors that influence the adoption of e-voting technology in Indonesia.

Emad Abu-Shanab, Michael Knight, and Heba Refai, (2010)	Explore factors that influence the adoption process of the E-voting systems of Yarmouk University students.	A survey research method was built to explore different aspects of students' acceptance of E-voting systems.	The usefulness and ease of use of e-voting system are the factors that affect the implementation of E-voting systems
Mourine Achieng and Ephias Ruhode, (2013)	Explore the factors that could influence the adoption of E-voting from the perspective of the citizens and the Independent Electoral Commission of South Africa	The exploratory qualitative method was held with an interpretive approach	The usefulness of the technology, Ease of use, Trust in the technology, resources, and infrastructure, and environment are the influence of the adoption of e-voting system
Charles Ayo, Adebiyi, A. A., and Sofoluwe, A. B., (2008)	Design an integrated voting system that encompasses EVM, I-Voting, and M-voting for Nigeria Election Commission	Survey of relevant literature is conducted to obtain the state of the art of e-voting implementation and the associated snags - to design an integrated voting system interoperated based eXtensible Markup Language (XML) and eXtensible Stylesheet Language (XSL) has been used	Design an efficient and effective integrated system that satisfies the desires of the electorates

Table 2- 1: Empirical Related Work

As it is shown in the above table 2-1, the researcher has tried to assess the related works, which are mainly used to identify the factors that affect e-voting system implementation from seven nations.

Fouad JF Shat and Pamela Abbott (2016) have studied the main factors affecting e-voting service implementation in Palestine and they provide an in-depth analysis of the main issues relating to the Palestinian implementation of e-voting. They investigate the factors, which affect the implementation of the e-voting system in Palestinian as technological change, social, political, cultural contexts, and organizational issues. They also argue that the complexity of e-voting technology, trust issues related to electronic voting, and in-correctness of software are also considerable factors for e-voting system implementation. Muharman Lubis, Mira Kartiwi, and Yusuf Durachmanuthors (2018) have assessed the privacy and readiness of the electronic voting system in Indonesia. They identified that the implementations of e-voting in Indonesia have been affected by several factors such as social structure, human resources, and IT infrastructure. There is a trust issue, in e-voting implementation thought the country. The authors introduce up-to-date and discuss clear-cut solutions for multiple voting constraints and problems. They also suggest some consideration be taken care of to prevent the majority of known problems with e-voting and presents recommendations, which engage the citizen opinion and expert knowledge in the field to pinpoint the path to the successful implementation of the e-voting in respect of political decision and economic challenges.

Mourine Achieng and Ephias Ruhode (2013) have identified the adoption and challenges of electronic voting technologies within the South African context. They identified the problem of the existing voting system of the country as accessibility, logistical problem, and cost. They explore the factors that could influence the adoption of e-voting from the perspective of the citizens and the Independent Electoral Commission of South Africa. The factors that emerged from the findings of the study included the following; Usefulness of the technology, Ease of use, Trust in the technology, IT resources and infrastructure, and environment. Also, relative advantage, complexity, and compatibility would exert an important influence on both the Independent Election Commission and voter’s intention to adopt e-voting.

Charles Ayo, Adebiyi, A. A., and Sofoluwe, A. B. (2008) has identified the success factors of e-voting implementation in Nigeria as poor logistics of e-voting materials, shortage of the data capture machines, and the power to support the machines. Besides the logistics problems, there was all manner of irregularities reported.

They designed an efficient and effective integrated system that satisfies the desires of the electorates. The integrated system would avail the electorates the opportunity of casting their votes using the most convenient medium among the electronic voting machine, internet-voting, and mobile-voting. On the internet-voting medium of voting is ascertained, the appropriate format is displayed on the respective devices, and in mobile-voting, mobile devices the WML format is displayed which is a function of the size of the screen. Also, the researches indicate the success factors include making adequate preparations and get the electorates familiarized with whatever electronic devices to be adopted before being put to use, employing the use of biometric-based voter's hard to solve the problem of over-voting, provision of the multilingual ballot to cater for the teeming illiterate population.

This research is assessing the implementation of the e-voting system in the Ethiopian context by identifying the factors affecting the implementation.

2.11 Summary of Literature Review

This chapter has presented the results of literature reviews related to this research. The main emphasis of this chapter is on the concepts of the e-voting system, requirements for successful implementation of an e-voting system, factors that affect e-voting system implementation, and the experience of other countries of the e-voting systems. First, a general overview of e-government was presented from relevant literature. It has been discussed that the definition of e-government from a different perspective with its types and benefits. Among the various domains of e-government, e-democracy and e-voting were presented. Secondly, the concept and types of e-voting systems were discussed. IDEA (2011) classified the e-voting system as Direct Recording Electronic (DRE) systems, Optical Scanning Systems, Punch Cards, and Internet voting systems. The challenges of a traditional voting system of Ethiopia were also reviewed. Thirdly, the benefits of the e-voting system were presented. E-voting system is the quickest, cheapest, and most efficient way to administer election and count vote. The fourth part of this chapter is the discussion of the experience of developed and developing countries in e-voting system technology. From the developed countries, the Belgium and Australia experience of the e-voting system was reviewed while from the developing countries the Brazil, Philippines, and Namibia experiences were discussed. Legal, Technical, and Procedural requirement of e-voting system implementation are discussed. Under the fifth part of this chapter, factors affecting e-voting system implementation were discussed.

According to Achieng and Ruhode (2013), the factors that affect the implementation of e-voting systems are ICT resources and infrastructure, the usefulness of the technology, ease of use, trust in the technology, and environment. Lack of infrastructure and resources would fend off the adoption of e-voting system. Recently the ICT sector in Ethiopia shows some growth and development. However, it is still far behind several African countries. It is also one of the countries with very low Internet penetration. Related empirical work is also part of this chapter.

CHAPTER THREE

RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This section describes the research design and methods that were used to answer the research questions and to achieve the research objectives. It starts by introducing the research design, what research approaches were used, why this research approach was used, research strategy, and sampling technique. The research data collections were also discussed. It also discusses the data analysis mechanism as well as discussions on the validity and reliability of the research.

3.2 Research Design

Durrheim (2004) defines research design as a strategic framework for an action that serves as a bridge between research questions and the execution, or implementation of the research strategy. Research design is an approach that a researcher uses to conduct a scientific study. It is the overall synchronization of identified components and data resulting in a plausible outcome. It constitutes the blueprint for the collection, measurement, analysis of data, interpretation, and reporting of conclusions.

3.2.1 Research Approach

The research approach encompasses the plans and the procedure of research. Chetty (2016) defines the research approach as a plan and procedure that consists of the steps of broad assumptions to the detailed method of data collection, analysis, and interpretation. It is, therefore based on the nature of the research problem being addressed. The three common approaches to conducting research are quantitative, qualitative, and mixed methods (Creswell, 2013).

Quantitative research begins with a problem statement and involves the formation of a hypothesis, a literature review, and a quantitative data analysis. Creswell (2013) states, quantitative research employ strategies of inquiry such as experiment and surveys and collect data on predetermined instruments that yield statistical data. The findings from quantitative research can be predictive, explanatory, and confirming.

A mixed approach to research is used when the integration of qualitative and quantitative data and analysis provides a better understanding of the research problem than either of each alone (Creswell, 2013). The basic premise of this methodology is that it permits a more complete and synergistic utilization of data than do separate quantitative and qualitative data collection and analysis.

Qualitative research is a holistic approach that involves discovery. Qualitative research is also described as an unfolding model that occurs in a natural setting that enables the researcher to develop a level of detail from high involvement in the actual experiences (Creswell, 2013).

This study aims to analyze gaps in Ethiopia's readiness for e-voting system implementation from the supply side, identifying the gaps in ICT resources and infrastructure, human resources, government willingness, and legal framework. To answer the research questions and to accomplish the objectives of the research qualitative data collection and analysis techniques have been used. Qualitative data collection techniques are used to gain an in-depth understanding of the problems associated with the voting by interviewing the election expert from the national election board of Ethiopia. Through semi-structured and unstructured interviews, the researcher collects qualitative data about the ICT resource and infrastructure, legal framework, and human resource, which considered as a pillar to implement the e-voting system.

3.2.2 Research Strategy

A Research Strategy is a systematic plan of action that gives direction to researcher thoughts and efforts, enabling the researcher to conduct research systematically and on schedule to produce quality results and detailed reporting. This enables one to stay focused, reduce frustration, enhance quality, and most importantly, save time and resources (Jenny, 2014).

Within research methodology, the research strategy assumes as the general plan of how the researcher will go about answering the research questions (Saunders et al. 2009). Saunders et al. also emphasized that the choice of the research strategy is guided by research questions and objectives. According to Saunders et al., research strategy is classified as experiments, surveys, case studies, ethnography, grounded theory, action research, and archival research. For this research, the researcher uses a case study as a research strategy.

3.2.2.1 Case-study

The case study, though dominantly a qualitative study design, is also prevalent in quantitative research. Yin (2003) defines the case study as an empirical inquiry that investigates a contemporary phenomenon within its real-life context; when the boundaries between phenomenon and context are not evident; and in which various sources of evidence are used. In most cases, a case study method selects a small geographical area or a very limited number of individuals as the subjects of study. The data collection for a case study is extensive and draws from multiple sources such as direct or participant observations, interviews, archival records or documents, physical artifacts, and audio-visual materials. The researcher must spend time on-site interacting with the people studied (Williams, 2007).

A case study is adopted for this study because it provides opportunities for the researcher to gather data from multiple sources includes pieces of literature in e-voting system implementation from other countries. The researcher is also expected to analyze case studies of various electronic voting systems from various countries to have a deeper understanding of how it works its security implications, challenges, and benefits. The case-study method also used to conduct interviews with NEBE staff to clarify the understanding of the e-voting system requirements.

3.2.3 Target Population

The study is carried out within Ethiopia and the targeted population of the study is Election Operation and Logistic Directorate, Human Resource Directorate, Legal Service Directorate, and IT Directorate of NEBE. Also, the Government Electronic Service Application Development and Administrative Directorate, and Government ICT Network Development and Administrative Directorate of MInT are the targeted populations.

3.2.4 Sampling Techniques

As explained by Acharya et al. (2013), sampling can be broadly classified as probabilistic and non-probabilistic. Accordingly, in probability sampling, each individual in the population has an equal chance of being selected in the study. However, in a non-probabilistic sampling method, the probability that a subject is selected is unknown. In probability sampling design, every item of the population has an equal chance of inclusion in the sample. However, in non-probability sampling things are not left to the chance.

For this study, a non-probability sampling technique is selected, because it is common in qualitative research method. Qualitative inquiries are to explore the diversity; sample size and sampling strategy do not play a significant role in the selection of a sample. If selected carefully, diversity can be extensively and accurately described based on information obtained even from one individual (Kumar, 2011).

Among the non-probability sampling design, purposive sampling was selected for this study. In Purposive sampling, sampling is done with a purpose in mind. Purposive sampling techniques selected based on characteristics of a population and the objective of the study (Crossman, 2019).

Purposive sampling also enables researchers to squeeze a lot of information out of the data that they have collected. Purposive sampling extremely time and cost-effective when compared to other sampling methods.

From here, purposive sampling is used to select two interviewees from one hundred and seven of the Human Resource Directorate, two interviewees from eight of the IT Directorate, two interviewees from three of the Legal Service Directorate, and two interviewees from thirty Election Operation and Logistic Directorate of the NEBE. The reason why the researcher purposively selects is that they are familiar with the challenges of e-voting technology adoption and the factor that affects e-voting technology readiness such as human resources and the legal structures.

Also, the target population of the study includes the Government Electronic Service Application Development and Administrative Directorate, and the Government ICT Network Development and Administrative Directorate of MInT, with this in mind; one interviewee from each directorate would be selected from a total of thirty to obtain detailed information on the ICT infrastructure readiness of the country.

3.3 Research Techniques

3.3.1 Data Collection Methods

Methods of data collection in qualitative research follow a convention. Qualitative methods are characterized by flexibility and freedom in terms of their structure. There are three main methods of data collection in qualitative research: In-depth interviews, observation methods, and document reviews (Kumar, 2011). For this study, the researcher employed qualitative data that were obtained from a qualitative interview and document review.

3.3.1.1 Qualitative Interviews

Qualitative interview attempts to understand the world from the subject's point of view, to unfold the meaning of people's experiences, to uncover their lived world before scientific explanations (Sewell, 2002). Qualitative interviewing provides a method for data collection rich and detailed information about how individuals experience, understand and explain events in their lives. Among the three most common types of interviews, semi-structured and unstructured interviews are included in the qualitative interview (Edwards and Holland, 2013).

Semi-structured and unstructured interviews provide freedom for a researcher in terms of content and structure. In-depth interviews, focus group interviews, narratives, and oral histories are prevalent types of unstructured interviews in qualitative research (Kumar, 2011).

In this study, to gather data, the researcher employs an in-depth interview. The in-depth interviewing technique involves conducting intensive individual interviews with a small number of respondents to explore their perspectives on a particular idea, program, or situation (Boyce and Neale, 2006). In-depth interviewing is repeated face-to-face encounters between the researcher and informants directed towards understanding informant perspectives on their lives, experiences, or situations (Taylor and Bogdan, 1998).

An in-depth interview is conducted with the staff of NEBE and MInT. There are several reasons why this tool has been employed for the study since it helps the researcher to get first-hand information about the readiness of the country for the e-voting system implementation from the supply side.

Interview questions will be prepared by adopting from IDEA (2011), International Conference on Information Systems Development (Shat, 2016), and International Journal of Innovation and Scientific Research (Agbesi, 2016) and modified according to researcher case

modified, and give to the election board and MInT staff. The interview question has five parts the first part is problems of the current voting system of the country and the challenges of adoption of the e-voting system, which is used to interviewee election experts from the Election Operation and Logistic Directorate of the NEBE. The staffs of Government Electronic Service Application Development and Administrative Directorate, and Government ICT Network Development and Administrative Directorate of MInT were interviewed to identify the gaps of the ICT infrastructures of the country. The rest part of the interviews is used to the interviewee the IT Directorate, Human Resource Directorate, and Legal Service Directorate of the NEBE to identifying the gaps related to IT infrastructure of NEBE, legality, and human resources. The result of the interview helps to identify the factor that affects the readiness of Ethiopia for e-voting systems implementation.

3.3.1.2 Document Analysis

Document analysis is a systematic procedure for reviewing or evaluating documents both printed and electronic (computer-based and Internet-transmitted) material. Like other analytical methods in qualitative research, document analysis requires that data be examined and interpreted to elicit meaning, gain understanding, and develop empirical knowledge (Corbin & Strauss, 2008).

Document analysis is a low-cost way to obtain empirical data as part of a process that is un-obtrusive and non-reactive. Often, documentary evidence is combined with data from interviews and observation to minimize bias and establish credibility (Bowen, 2009).

As one of the objectives of this study is to identify the country's technological capacity for e-voting system implementation, the study has tried to closely study the ICT infrastructure security mechanism and the country's internet coverage from recent reports, documents, and journals.

3.3.2 Data Analysis Method

Data analysis is the process of evaluating data using analytical and logical reasoning to examine each component of the data provided. Data analysis is a dynamic process weaving together recognition of emerging themes, identification of key ideas or units of meaning and material acquired from the literature.

Flick (2014) defines data analysis as the process of classification and interpretation of linguistic (or visual) material to make statements about implicit and explicit dimensions and structures of meaning-making in the material and what is represented in it.

Thematic analysis was used to analyze the data, which was gathered from the in-depth interviews and document reviews because it is a more powerful tool when combined with research methods such as interviews, observation, and use of archival records. Thematic analysis is a highly flexible method of research that has been widely used in the library and information science (LIS) studies with varying research goals and objectives.

Thematic analysis is a method for systematically identifying, organizing, and offering insight into, patterns of meaning across data. The thematic analysis allows the researcher to see and make sense of collective or shared meanings and experiences (Braun & Clarke, 2006). According to Braun & Clarke (2006), the following steps are undertaken in thematic analysis: familiarization, generating initial codes, searching for themes, reviewing themes, naming themes, and producing the report. The researcher follows this process to analyze the data. To transcribe all data the researcher, listen to the audio-recorded data more than once, and read the textual data critically and analytically. Based on the transcribed data the researcher generates codes for searching themes.

3.3.3 Validity and Reliability

Validity and reliability are the two most important and fundamental features in the evaluation of any measurement instrument or tool for research. Without assessing the reliability and validity of the research, it will be difficult to describe the effects of measurement errors on theoretical relationships that are being measured (Forza, 2002).

Validity in qualitative research means appropriateness of the tools, processes, and data. Whether the research question is valid for the desired outcome, the choice of methodology is appropriate for answering the research question, the design is valid for the methodology, the sampling and data analysis is appropriate, and finally, the results and conclusions are valid for the sample and context (Leung, 2015). Several validities increase the appropriateness, and accuracy of research. Johnson & Christensen (2004) have described many forms of validity in qualitative research as researcher bias, internal validity, and external validity.

External validity involves the extent to which the results of a study can be generalized (applied) beyond the sample. Internal validity reflects that a given study makes it possible to eliminate alternative explanations for a finding.

Reliability concerns the faith that one can have in the data obtained from the use of an instrument, that is, the degree to which any measuring tool controls for random error. Joppe (2000) defines reliability as the degree to which results are predictable over time and an accurate representation of the total population under study. Also, if the results of a study can be reproduced under a similar methodology, then the research instrument is considered reliable. Bias can occur in the planning, data collection, and analysis and publication phase of research. Understanding research bias, and how it affects the result of research increase the validity and reliability of the research.

To increase the study validity and reliability and to reduce possible basis the researcher would take the following techniques:

- To avoid sampling bias the researcher design sampling frame that matches the targeted population. The researcher only interviewee to those respondents who are trusted representatives of the targeted population.
- To avoid interviewer bias the researcher clearly understands and identifies what information is obtained from the respondent. The researcher spends a period in the situation before data collection starts. The researcher will then become sensitized to the situation and at the same time, the subjects have the opportunity to become used to the presence of the researcher.
- The researcher patiently waits for the answer of the respondent and avoids things, which affect the respondent in the time of interview and record interview results through tape-recorder.
- To increase the validity the researcher builds a trust-relationship with the respondent and staying with them for more than two days. Also, the researcher discusses with the respondent about the reason why the research is conducted, why the data is collected, and how the data is collected. The researcher also interviewing the same respondent on several occasions and comparing the results obtained with other evidence.
- To increase internal reliability with data analysis the researcher, precisely use the same words obtain from the respondent and gives the result of data analysis to the respondent for further review.

3.4 Chapter Summary

This chapter presented the research design and methodology employed in this study. To achieve the objective of the study qualitative research was employed. The case study research method was adopted to further explore factors that determine e-voting systems' readiness. From the qualitative research data, collection instrument in-depth interview and document review are employed to identify the gaps in the readiness of technology infrastructure, human resources, and legality of e-voting. Overall, this chapter presented the research design, research strategy and extension methods, data collection instruments, and data analysis techniques related to qualitative research.

CHAPTER FOUR

DATA PRESENTATION, ANALYSIS, AND DISCUSSION

Introduction

This chapter presents the findings and analysis of the data obtained from the in-depth interview and document review. The findings from the in-depth interview are categorized into four sections. This includes challenges in the adoption of e-voting technology, the readiness of IT infrastructure, the readiness of human resources, and the existence of a legal framework for e-voting technology. To address this, data was gathered by interviewing the staff of NEBE and MInT. The discussion section points out links between the research question and the findings. As stated in section 3.3.2 thematic analysis has been employed to analyze the data.

4.2 Respondent Information

For this research, ten interviewees are composed of eight from the National Election Board of Ethiopia and the remaining two are from the Ministry of Innovation and Technology. The interviewee from the NEBE and MInT were selected depending on their job position and the researcher believed that they could provide quality information about the factor, which affects the readiness of the e-voting system from the government side.

The respondents from the two offices were summarized in Table 4-1 below.

Table 4- 1: Respondent distribution in the offices

Offices	**Number of Respondents**
National Election Board of Ethiopia	8
Ministry of Innovation and Technology	2
Total	10

As can be presented in, table 4-1, eight interviewees are selected from NEBE from four Directorates i.e. Election Operation and Logistic, Human Resource, Legal Service, and IT. The other two interviewees are from the Ministry of Innovation and Technology. One is from Government Electronic Service Application Development and Administrative Directorate and the other is from Government ICT Network Development and Administrative Directorate.

These respondents again presented in a more detailed way to their office, directorate, or (department), working positions, educational status, and work experiences on the current positions.

Table 4- 2: Respondents' demographic distribution

Respondent	Office they work	Directorate (department)	Current Working Position	Educational Status	Work Experience		
					On current position	Other	Total
1st respondent	NEBE	Election Operation and Logistic	Team Leader	BSc/ first degree	15 years	5 years	20 years
2nd respondent	NEBE	Election Operation and Logistic	Senior Expert	BA/ first degree	15 years	-	15 years
3rd respondent	MInT	Government ICT Network Development	Team Leader	BSc/ first degree	4 years	2 years	6 years
4th respondent	MInT	Government Electronic Service Application	Project Manager	BSc/ first degree	11 years	-	11 years
5th respondent	NEBE	Information Technology	Director	BSc/ first degree	15 years	5 years	20 years

6th respondent	NEBE	Information Technology	Network administrator	BSc/ first degree	4 years	-	4 years
7th respondent	NEBE	Human Resource	Director	MSc/ second degree	5 years	9 years	14 years
8th respondent	NEBE	Human Resource	Higher personnel expert	BA/ first degree	7 years	5 years	12 years
9th respondent	NEBE	Legal Service	Director	MSc/ second degree	8 years	-	8 years
10th respondent	NEBE	Legal service	Higher Legal Expert	LLB	27 years	4 years	31 years

In the following two tables' respondents' educational status and work experiences are separately summarized.

Table 4- 3: Educational status

Educational Status	Number of Respondents
MSc/ second degree	2
First degree	8
Total	10

Table 4- 4: Work Experiences

Work Experience	Number of Respondents
Below 10 years	3
10-20 years	4
20 years and above	3
Total	10

As indicated in the above tables, from the 10 respondents interviewed, two have an MSc degree. The other eight have a BSc/BA degree. This statistical distribution showed that almost all of the respondents are educated to understand the interview questions and to respond appropriately. On the other hand, only 30% of respondents have work experience of 10 years and below while the reaming 70% were 11 years and above. This also reflects that the respondents have sufficient work experience. Furthermore, the interviewees who are engaged in this research are believed to be aware of the gaps in the readiness of ICT infrastructure, human resources, and legality measures for conducting the e-voting system.

4.3 Data Presentation

4.3.1 Data from the In-depth Interview

Under this part, the gathered data from in-depth interviews are presented. The data are recorded, transcribed, and coded into the following four thematic areas following the approach of Braun & Clarke (2006) as explained in section 3.3.2

- Paper-based voting system problems and challenges in the adoption of e-voting technology
- The readiness of ICT infrastructures and resources
- The readiness of human resources
- The existence of a legal framework for e-voting technology

Challenges in the Adoption of E-voting Technology

Interviewees were asked about the problem of the current paper-based voting system. Both the Team Leader and Election Expert of the Election Operation and Logistic Directorate of the NEBE stated currently, Ethiopia follows a paper-based voting system, which is prone to several problems.

Both interviewees stated the problems of the paper-based voting system as theft and fraud of vote, lack of trust, expensive i.e. government spent a large amount of money for training electors, inaccessible to disabled voters, election result delay, error in the vote-counting process and voting repetition. According to Election Expert, about 40 million voters are expected to vote in 547 election districts and 45, 812 polling stations in the coming 2021 G.C general election in a traditional way.

The Team Leader of Election Operation and Logistic Directorate of the NEBE understand the e-voting system as an election system that allows voters to vote electronically. It is a technology-assisted voting system.

Regarding the complexity of the adoption of the e-voting system, both interviewees agreed that the adoption of e-voting technology is difficult in light of the current state of the country. Interviewees explained the challenges of the adoption of the e-voting system. The Team Leader of Election Operation and Logistic Directorate of the NEBE stated that the Electoral Board of Ethiopia does not have the qualified human resources to support the adoption of the e-voting system, and this could be a challenge. The lack of ICT resources by the Electoral Board of Ethiopia is also a challenge for the adoption of e-voting technology. The unavailability of the legal framework is also a challenge to adopt the e-voting system from the supply side. The Election Expert of Election Operation and Logistic Directorate of the NEBE stated that to adopt an e-voting system a lot must be done such as expanding ICT infrastructure and resources of the country, training adequate human resources, and extracting legal framework for e-voting technology. He also said, “e-voting technology adoption is affected by illiteracy rate and poverty.”

As to the initiation of the Electoral Board on the adoption of the e-voting system, interviewees agreed that there is a high level of motivation and interest on the side of NEBE to conduct an election by e-voting technology. In 2012 G.C, the National Election Board and Ministry of Innovation and Technology jointly began research for implementing the e-voting system. However, the research was not completed, due to problems of infrastructure, budget, and reforms. According to the Election Expert of Election Operation and Logistic Directorate of the NEBE, extensive sets of research are needed to adopt the e-voting technology.

Interviewees were asked about the willingness of the government to use technology for conducting a free and fair election and all interviewees claimed that there is a willingness on the government side. The Election Expert said:

"The government spends a large amount of money for election professionals to take the experience of e-voting systems from different countries like India, Belgium, and Namibia."

Interviewees were asked about the necessity of implementing e-voting systems and they explained that implementing an e-voting system is a solution to reduce the problem, which was raised in the traditional voting system. According to the Election Expert:

"NEBE spends a large amount of money to train around 250,000 election official in every five years. If e-voting were implemented it will reduce the money which is used for training purposes."

Interviewees were asked about the benefits e-voting regarding cost, trust, accessibility, and security and in line with this, the Election Expert of Election Operation and Logistic Directorate of the NEBE said that e-voting system provides several benefits for the country regarding trust, cost, accessibility, and security. The Team Leader of Election Operation and Logistic Directorate of the NEBE said:

"E-voting is beneficial regarding the reduction of voting fraud, inclusion of all eligible citizens across the country in the voting, and the immediate announcement of election results."

The Readiness of ICT Infrastructures and Resources

Interviewees agreed that inadequate ICT resources and infrastructures affect the implementation of technological innovation such as the e-voting system. In line with this, the Team Leader of Government ICT Network Development and Administrative Directorate of MInT stated that:

"The current ICT infrastructure of Ethiopia is not matured enough to implement the technological innovation works, specifically the e-voting technology."

The inadequate ICT resource and infrastructure of the country makes hard the implementation of technological innovation works. The Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT stated that:

"Lately the government of Ethiopia performs several tasks to expand the ICT infrastructures and resources. One of the highlights of this is the willingness of the government to engage the private sector in the government-owned telecommunication sector."

According to Team Leader of Government ICT Network Development and Administrative Directorate of MInT:

"The existing ICT resource and infrastructure of the country do not encompass the entire parts. In most rural areas, there is no sufficient network and internet coverage. As a result, it is impossible to implement the e-voting system across the country."

The Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT further explained that recently the government of Ethiopia implemented some technological platforms like SchoolNet and WoredaNet, but the implementation of such platforms was not as effective as it was intended due to the lacks of ICT infrastructure. Interviewees indicate that there is no adequate investment in ICT infrastructures and resources; as a result, it can be one barrier to address the technologies for the entire society and to update the government services.

Regarding ICT infrastructure requirement for e-voting system implementation, the Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT stated that for implementing an e-voting system the following ICT resources are needed: accessible telecom network, internet access, computer hardware, and software, voting devices, secure data transmission system, and secure data center.

Interviewees agreed that there is no adequate security mechanism to protect IT facilities throughout the country. According to the Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT, currently, the government of Ethiopia is working on various aspects to protect IT infrastructures and resources. The government of Ethiopia has a long-term plan to implement Public Key Infrastructure (PKI). He defined PKI, as "the set of hardware, software, policies, and procedures required for creating, managing, storing, and distributing digital certificates and managing public-key encryption." Also, the government is working to raise awareness of private and public organizations to protect their IT resource and infrastructure. There is a lack of coordination across the country to protect ICT infrastructures and resources. According to the Team Leader of Government ICT Network Development and Administrative Directorate of MInT, the problem of collaboration among different government and private organizations are widely recognized in the handling of ICT resources and infrastructures of the country. Some government and private organization damage the underground IT infrastructure when they carried out their separate work. This is one of the main reasons for internet and network interruption. As explained by the Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT, Ethio Telecom is working with different stakeholders to increase the awareness of the community. Telecommunication infrastructure is crucial for e-voting system implementation. E-voting technology cannot be effectively implemented without a secure telecom infrastructure.

Interviewees agreed low internet connectivity affects the implementation of the e-voting system. In line with this, the Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT said:

"*Reducing internet interruption is the first task that is to be done before implementing technological innovation. Without a stable internet connection, it is impossible to use web-based application services. Internet connection problem is a barrier for updating service delivery mechanism of different government and private organization. In addition to underground snipe of cable, inadequate supplies of electricity are a major cause of the internet and network interruption."*

Interviewees explained that e-voting is one of the applications of e-government, which plays an important role in the building of good governance. The Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT stated that:

"The main purpose of e-government is promoting good governance. Now a time the government of Ethiopia uses some technology for providing services in an efficient, clear, and accessible way. The services that are provided by the government using technology are included in e-government. Although until now e-voting was not implemented, it is one of the e-government applications that play an important role in democracy development."

Interviewees explained the initiation of MInT to support the implementation of the e-voting system. The Project Manager of Government Electronic Service Application Development and Administrative Directorate explained that MInT is willing to support and monitor e-voting activities if there is an initiation in the election board about e-voting. Before eight years MInT and NEBE together started a pilot work on the e-voting system implementation, but not have been completed. Yet again if there is any motivation in the NEBE about the e-voting system, MInT is willing to support it.

Regarding the IT infrastructures and resources of the National Election Board of Ethiopia, the IT Director and Network Administrator of NEBE agreed that the current ICT infrastructures of NEBE are inadequate for e-voting system implementation. In terms of IT infrastructure, there are unmet needs in the organization. The IT Director of the NEBE said:

"Currently there are certain IT infrastructure like data center, internet, and pcs. The organization faces frequent server crashes due to the quality of the existing server, as a result, a noticeable problem of information dissemination is observed. Sometimes there is a problem of internet connection due to the breakdown of electric power, in such case the organization use generator."

According to the data obtained from the interviewees, NEBE uses 26 Mb/s internet speed. The election board uses LAN connectivity to transmit the data at very fast rates also; many users of the organization access the data through the organization LAN. The IT Director states the problem of internet interruption of the NEBE as:

"*Occasionally there is internet interruption in the election board, in such case; immediate action has been taken to solve the problem by communicating with Ethio Telecom. The servers, switches, cables, and computers have had many years of use and have an impact on internet interruption.*"

Interviewees were asked about the mechanisms used by the election board to protect IT infrastructures. According to the IT Director of the NEBE, certain physical protection measures are taken such as a lock of the data center room and switch boxes. The data center room is located in the ground flower and to protect it surveillance camera, firewall, and intrusion detection mechanism has been used. Awareness training was also given for all employees of the election board to install anti-virus and to use a personal password in their PCs. Based on the data obtained from the interviewees the election board has a plan to fulfill basic ICT facilities and in line with this the IT Director of NEBE said:

"There is a network infrastructure plan to connect the nine regions branches with each other and with headquarter via VPN. The main purpose of this plan is to increase the speed of communication with branches and head office. The other plan of NEBE related to ICT facilities is the changing of existing IT devices of branch offices and headquarter into the same brand."

The election board has a significant budget shortage for meeting the requirement of basic IT facilities, which can be considered as a reason for lagging of works in the election board.

The Readiness of Human Resources

According to the data, obtain from the interviewees to implement e-voting system trained, and knowledgeable human resources are needed. Before implementing the e-voting system, the government must train adequate human resources. Skillful human resources are needed to solve technical problems of the e-voting machines that may arise during the vote casting process.

Interviewees agreed with no responsible expert in the election board who assesses the readiness of the e-voting system environment. Since e-voting yet has not been implemented in Ethiopia, due to that there are no experts in e-voting technologies. According to the data, obtained from the interviewees in the Electoral Board, the IT Directorate is responsible to provide technology-related training for employees. The IT Directorate provides training to the employees on several occasions to develop their computer skills. However, there is no training available to the employees about e-voting technology.

When interviewees were asked awareness of employees about the e-voting system. The Human Resource Director of the NEBE said:

"No training is provided for employees of the electoral board regarding e-voting technologies; as a result, it is difficult to say that all office staff has awareness of e-voting technology. However, some employees of the election board went to Belgium, India, and Namibia to take experience in the e-voting technologies."

When interviewees were asked about the existence of leadership support in the e-voting technology, the Human Resource Director of NEBE stated that:

"In the election board, the concept of e-voting was raised in recent times. The management staff of the board show interest in the implementation of the e-voting system. However, the management staff of the board did not support the e-voting system implementation. One of the obstacles to the failure of the e-voting system was the continual reform that has been happing in the election board."

The Human Resource Director and the Higher Personnel Expert of NEBE explained the impact of recognition and reward on the employee's performance as, in the election board there is no tradition of recognizing, and rewarding employees who achieve the highest result. The structure of the election board was one reason for the discouragement of employees. Some of the directorate like finance, human resource, and audit actives in all year while some others are available in the time of the election, which makes difficult to measure employee's performance. Due to that, the election board does not provide recognition and reward for all staff. Interviewees agreed that continually employees with experience leave the election board. The reason for the high turnout in the election board is low salary and unfulfilling of benefits. In recent times, the board has launched an actual plan to meet employees' benefits and increase wages. The Higher Personnel Expert of NEBE said:

"The adjusted benefit and salary help the election board to retain employees with experience and skill."

Interviewees explained the organizational, managerial, and personal factors that influence NEBE employee's performance. Higher Personnel Expert of Human Resource Directorate of the NEBE explained organizational factors as in some offices of the election board there is a lack of facilities such as a supply of water. The compound of some offices is not attractive. There is also a strategic problem at the head office of the election board, that is, not all directorates are in the same place, making it difficult to communicate with one other and to exchange information. The Human Resources Director of the NEBE stated the factor related to management as the managerial staff of the electoral board does not influence the employees by any means without managing and encouraging them.

Interviewees explained the government provision of trained human resources in e-voting technology. The election board did not request the government to get skillful human resources in the area of e-voting because no election is conducted through e-voting in the country. If the government and election board decided to conduct election through e-voting, it is possible to train human resources by communicating with the educational institutions. According to the data obtained from the interviewees, the government of Ethiopia provides financial support for fulfilling different facilitation of the election board. The national election board also receives financial and material support from the donors.

The Existence of a Legal Framework for E-voting Technology

Interviewees agreed that the legal structures affect the implementation of e-voting technology. Having a legal framework for e-voting technology helps to protect the basic democratic rights of people before, during, and after the election, where the election is conducted by the e-voting system. The Legal Service Director of the NEBE stated that:

"According to international principles, any election must be inclusive, free, and fair. Therefore, before conducting election through the e-voting system those international principles must be considered and should be included in the legal framework. He also pointed out that there is no idea in the constitution of FDRE about e-voting technology. There is no clear principles and regulation about the e-voting system; this is because there are no issues from the management of the election board and the government about e-voting technology."

The interviewees mention the existence of principles and regulations about e-voting technology in the proclamation. The Higher Legal Service Expert of the NEBE explained that noting on the proclamation about e-voting system, however, the Ethiopian Electoral, Political Parties Registration, and Election's Code of Conduct Proclamation No. 1162/2019 on Article 51, number 8 says; the Board may deploy technology to assist with the voting and, following the vote-counting processes. This shall be done in consultation with contesting political parties and the particulars shall be determined by a directive to be issued by the Board.

The willingness of the legislative body of the country to formulate a legal framework for the e-voting system explained by the interviewees, the Higher Legal Expert of the NEBE said:

"When the election board and government want to use e-voting technology as the electoral system, the legislative body of the country incorporates the e-voting system in the electoral proclamation. Based on the proclamation the election board establishes specific principles and regulations about the e-voting system. However, as far as the government and election board did not provide any idea about e-voting technology for the country's legislative body, there is nothing to say about the willingness of the country's legislative body."

The Higher Legal Expert of the NEBE also said the election board has no lack of willingness to publish voting regulation and principles defined on the grounded proclamation. The election board uses different means to make them available for people and political parties. Interviewees explained the need to extract the legal framework for e-voting technology. The Legal Service Director of the NEBE said:

"Extracting a legal framework for the e-voting system is not questionable. Any electoral system requires a legal framework, before using the e-voting system, as a means of election mechanism the legal provision must be enacted."

The advantages of formulating a legal framework for the e-voting system explained by Legal Service Director of the NEBE as to make compatible the e-voting technology with the existing laws and principles of the country, to make e-voting system lawful and regulated on the country and to list transparency and security mechanism of e-voting system.

According to the data obtained from the interviewees before using e-voting technology, the election board first discusses the concept and benefits of e-voting technology with different stakeholders. Based on the discussion the election board asks the country legislative body to extract legal framework for the e-voting system. Based on the request the legislative body of

the country extracts a legal framework for the e-voting system and presents it to the house of people representative for approval.

4.3.2 Document Reviews

Another data was collected from documents related to the country security mechanism of the IT infrastructure and internet coverage.

Telecommunication and IT Infrastructure Security Mechanism of the Country

Ethio Telecom is an organization under the Ministry of Innovation and Technology, Govt. of Ethiopia, is the sole organization responsible for providing the Telecom and Internet Services in Ethiopia. Ethio Telecom is making all-out efforts to not only modernize and expand the existing communication network countrywide but also to improve the quality of service and reliability, to eventually provide the Telecom and ISP services to its customers at affordable rates. Ethio Telecom takes different measurements to protect the ICT infrastructure of the country by cooperating with different stakeholders. The proclamation of Protection of Telecommunication and Electric Power Networks (2005) define telecommunication networks as any equipment or accessories thereof, satellite, optical fiber, wire, cable, tower, mast, antenna, and any structure used or intended to be used in connection with telecommunications system. Those telecommunication networks are expanded all over the country and the sector by its very nature is exposed to illegal acts and the interruption of the services, even for a while, will bring damage to the national economy and security of the country. According to the annual report of Ethio Telecom (2019) within the budget year, the company loses 100 million birrs to cable theft and vandalism. The report says telecommunication infrastructure robbery and damage highly disrupted the activity and affected the quality of service. The telecommunications networks all over the country are hereby provided special protection by this Proclamation. Any federal and regional administrative body shall, in collaboration with the telecommunication service provider have the duty to protect telecommunications networks. Ethio Telecom uses a variety of tactics to protect cellular towers across the country such as building a fence and employing guards.

Country's Network and Internet Coverage

In Ethiopia, the only internet service and mobile communication provider is Ethio Telecom. According to the annual report of Ethio Telecom, in 2019 there are around 7,100 cellular towers, connected by microwaves, to provide mobile service coverage. From the mobile subscribers of the Ethiopian population, around 85% obtain 2G mobile network coverage's, 66% gets 3G, and 4% of user obtains 4G. According to the 2019 reports of internet world stats, the internet penetration of Ethiopia is around 19%. In January 2019, Ethio Telecom launches 4G connection options for only the Addis Ababa city; as a result, the connection speed reaches 3Mbit/s for mobile devices.

4.4 Discussion

The purpose of this study was to identify Ethiopia's readiness for the e-voting system implementation from the supply side. The study aimed to address the following research questions to identify the gaps in the country's readiness for e-voting system adoption.

4.4.1 How ready is Ethiopia to adopt the e-voting system from the supply side?

E-voting system will reduce the problem of the traditional ballot voting system of Ethiopia. The paper-based voting systems, which are practiced by Ethiopia, encounter many problems. The paper-based voting systems are often tedious, insecure, expensive, non-inclusive, and delayed elections (Achieng and Ruhode, 2013). The interviewees support this, where the Team Leader and Election Expert of Election Operation and Logistic Directorate of NEBE mentioned the problems of paper-based voting systems of Ethiopia as venerable to theft and fraud of vote, delay in voting result, inaccessible to disabled voters, expensive, over-voting and problems in the vote-counting process. The e-voting system is a solution to update the electoral process of the country, to reduce the problem of the traditional voting system, and to gain trust among the community and opposition parties. Achieng and Ruhode (2013) also said nations like Namibia, Brazil, and Australia adopt electronic voting systems to address numerous challenges related to costs of the physical ballot paper and other overheads, electoral delays, distribution of electoral materials, and general lack of confidence in the electoral process.

E-voting technology provides several benefits. IDEA (2011) stated the benefits of e-voting technology as faster voting and tabulation, exclusion of human error, laborious counting procedures, improved presentation of complicated ballot papers, increased participation, prevention of fraud at polling stations and during the transmission and tabulation of results, increase accessibility with internet voting for disabling voters and voters from abroad. Also, offer long-term cost savings by reducing poll worker time, and reduced costs for the manufacturing and distributing of ballot papers. No shipment costs, no delays in sending out material, and receiving back. Participant of the interviewees in the NEBE assured that e-voting technology provides several benefits like reducing voting fraud that was raised in the previous election, accessible to eligible citizens across the country, quick election result announcement, reduce costs, secure and trustfulness.

A finding from the study of Krimmer and Schuster (2008) identified the determinant that affects the readiness of the e-voting system as IT infrastructures and resources, legal structures, human resources, and social structures. E-voting readiness also requires the readiness of the Electoral Board to use technology for the election process within its internal structures. The interviewees of Election Operation and Logistic Directorate agreed that the country is not ready to adopt the e-voting technology. Eight years ago, the Ethiopian Electoral Board and MInT jointly began a trail to deploy e-voting technology. However, the trail was not completed, due to inadequate IT infrastructures, lack of qualified human resources, the lack of budget, and continual reforms. The election expert stated that much needs done by NEBE and another stakeholder to be ready for e-voting technology adoptions, such as expanding IT infrastructure and resources of the country and the electoral board, training adequate human resources, and extracting legal framework for an e-voting system. The Election Expert also said extensive researches sets are required for adopting e-voting technology. The willingness of the government to use technology for conducting a free and fair election and the experience of e-voting technology from the different nations is the groundwork for the adoption of e-voting technology. The study revealed that there was no readiness in ICT infrastructures and resources of the country as well as the Electoral Board for e-voting technology adoption. There were also no knowledgeable, experienced, and qualified human resources in the country that supports e-voting technology adoption. The study also found that there was no legislative framework for e-voting technology in the country. As a result, the country is not ready to adopt e-voting technology from the supply side.

4.4.2 What are the possible gaps for the successful implementation of e-voting systems?

A finding from the study of Kunle Ajayi (2013) identified several factors that affect the implementation of the e-electoral system in Africa. This includes leadership ineptitude and lack of political will, regional insensitivity, ICT infrastructure and resource, qualified human resource, legal framework, corruption, mass poverty, secrecy, and lack of open governance, economic hardship, illiteracy, poor quality of leadership and leadership failure.

One of the several factors that influence the implementation of e-voting technology is ICT resources and infrastructures. The ICT infrastructure team leader of MInT supports this; she said inadequate ICT resources and infrastructure affect the implementation of the e-voting system. Ethiopia's existing ICT resources are not matured enough to implement technological innovation, specifically the e-voting system. The lack of ICT resources and infrastructures within the county makes the implementation of technological innovations difficult. The country's existing ICT infrastructures cannot support nationwide e-voting system implementation.

The finding of the study of Agbesi Samuel (2013) identified ICT infrastructural requirements for the successful nationwide implementation of an e-voting system. This includes fiber links, microwave links, and voting devices. The Project Manager of MInT support this; he said the implementation of an e-voting system requires accessible telecommunications network, Internet connectivity, computer hardware, and software, voting devices, secure data transmission system and a secure data center. ICT resource and infrastructure serves as a keystone for any types of e-voting technology. E-voting technology uses ICT resources and infrastructures in pre-voting, while-voting, and post-voting processes. The process includes voter registrations, candidate display, vote casts, vote counting, result transmission, and result notification.

To transmit the election results from polling station to central consolidation centers telecom network and internet connectivity are required. The finding of this study show country's existing telecommunications infrastructure does not encompass the entire parts. In most rural areas of the country, there is no sufficient network and internet coverage. The mobile network converges of Ethiopia do not reach in the entire parts, even if there is no absolute 2G mobile network coverage. This indicates a gap in the telecommunications network requirements for the successful e-voting system implementation.

In Ethiopia, Ethio Telecom is the only government organization that provides telecommunications and internet service for about 114,963,588 peoples, which indicates a gap in the investment of ICT infrastructures and resources. Even though the existing ICT resource and infrastructure of the country are exposed to theft and destruction. The finding of this study shows that there is a gap in coordination across the country to protect ICT infrastructures and resources. There is a gap in cooperation among the various organizations of the country in the handling of ICT resources and infrastructures. Some government and private organizations damage the underground IT infrastructures and resources when they carried out their separate task. Recently Ethio Telecom loses 100 million birrs due to cable theft and vandalism. The infrastructure robbery and damage highly disrupt the internet service and affect the quality of the network. The government conducts several tasks to protect the country's ICT infrastructures and resources, such as raising awareness of various governmental and non-governmental organizations, as well as communities, and building a fence for cellular network towers. The mechanism used to protect ICT facilities throughout the country is inadequate. The government of Ethiopia has a long-term plan to implement Public Key Infrastructures.

From the different types of e-voting systems, the i-voting system is the one that uses the internet for the voting process. Through i-voting voters are not expected to go in the polling station, rather they vote from any were. I-voting enables the people of the country residing around the world and wants to participate in the voting. The government of Australia uses i-voting for the 2007 G.C national election, which was limited to members of the Australian Defence Force who were serving in various locations, including Iraq and Afghanistan. The implementation of i-voting requires stabile, secure, and fast internet connection. The participants of the interviewees at the MInT have assured that the internet interruption and instability of the country is a barrier for implementing web-based applications like i-voting. As stated by the Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT, increasing internet speed and avoiding interruption is the first task to be done before implementing i-voting and other web-based applications.

The finding of the study of Yildiz (2007) stated that e-government implementations include the e-voting system for enhancing democracy and increase the direct participation of citizens and accountability. The Project Manager of Government Electronic Service Application Development and Administrative Directorate of MInT support this, he said the main purpose of e-government is promoting good governance. Now a time the government of Ethiopia uses some technology to provide services in an efficient, clear, and accessible way. Even though e-voting was not implemented, it is one of the e-government applications that play an important role in democracy development.

The implementation of e-voting technology also requires a well-organized internal structure of the organization regarding technology. Organizational readiness refers to the degree to which an organization is ready to implement IT innovation (in this case e-voting) in line with its internal structural characteristics (DOI, 1995). The finding of this research indicated that the national election board of Ethiopia does not have a secure, and well organized IT infrastructure. The IT Director and the Network Administrator of NEBE stated that the existing ICT infrastructures of NEBE could not support the implementation of the e-voting system. There is a lack of IT resources and infrastructure in the organization; this implies the election board is not fully ready for e-voting system implementation. As stated by the IT Director of the NEBE, inadequate IT infrastructure was one of the several reasons for the failure of the 2012 G.C e-voting system trail. E-voting technology requires the secure data center of the Electoral Board for storing and counting of vote data. The study revealed a gap in the IT infrastructure security mechanism of the election board. The IT Director of the NEBE said, to protect the IT facilities of the election board some physical security mechanisms are applied such as a lock of the data center room and switch boxes. The election board uses LAN connectivity to transmit the data at very fast rates; also, many users of the organization have data access through the organization LAN. The finding of this study shows that the election board has planned to facilitate IT resources and infrastructure. According to the data obtain from interviewees; there is a plan to connect the nine regions branches with each other and with headquarter via VPN, to increase the speed of communication with branches and head office. The other plan of NEBE related to ICT facilities is changing existing IT devices of branch offices and headquarter into the same brand. The NEBE will need additional ICT infrastructures and resources before e-voting system implementation will be possible.

Adequate and skillful human resources are also another factor that affects the implementation of e-voting technology. The finding of the study of Pahlevi (2015) stated that the skill of human resources plays a significant role in e-voting system implementation. Participant of the interviewees supports this idea. The Human Resource Director and Higher Personnel Expert of the NEBE stated that the implementation of the e-voting system requires qualified and knowledgeable human resources. There are no sufficient human resources in the electoral board to e-voting technology implementation. Before implementing the e-voting technology continues, training should be given for staff involved in elections by the concerned body to reduce technical constraints (Oguejiofor, 2018). In the NEBE, there is a gap of providing e-voting technology-related training to employees. As a result, it is difficult to say that all office staffs are aware of e-voting technology. However, some employees of the election board went to Belgium, India, and Namibia to take experience in e-voting technologies. There is also a gap in leadership support. NEBE Human Resource Director said that the top executives of the election board have an interest in the e-voting system, but they do not support its adoption because of the on-going reform that has taken place in the election board. A finding from the study of Thao & Hwang (2011) identified the main factor-affecting employee's performances in the organizations. This includes the leadership style of the organization, motivation, and training. Reward, recognition, promotion, job enrichment, and payment system of an organization are included in the motivation factors of employees' performance. The finding of this research indicates that the reward, recognition, and payment system of NEBE affects the employees' performance. There is no tradition of a reward and a recognition system in the NEBE. This is because of the organization's structure. Some directorates work throughout the year, while some are work only at the time of the election, making it difficult to measure the performance of employees. There is high turnout in the election board due to low salaries and unfulfilling benefits. The Higher Personnel Expert of the NEBE said that in recent times, the board has launched an actual plan to meet employees' benefits and increase wages. The management staff of the electoral board does not influence employees without motivating them. Organizational factors also affect the performance of employees. Some offices of the NEBE have a lack of facilities such as water supply. There is a strategic problem in the headquarters of the election board, i.e. not all directorates are located in the same place, making it difficult to communicate and exchange information with each other.

The government of Ethiopia has a gap in the provision of human resource that knows the e-voting system to the electoral board. The Human Resource Director of the NEBE stated that if the government and election board decided to conduct election through e-voting, it is possible to train human resources by communicating with the educational institutions.

Democracy-oriented legal framework and constitutional requirements are necessary for the implementation of the e-voting system (Mitrou, Gritzalis, Katsikas, and Quirchmayr, 2009). The Legal Service Director of the NEBE supports this and has stated that following international law there must be regulation and direction that shows how the elections are conducted. Such regulation and direction shall be included in the legal framework. The legality of e-voting technology must be considered before the election is conducted through the e-voting system. The legal framework of the e-voting system helps to protect the basic democratic rights of the peoples in the election process.

The finding of the study of Bishop and Hoeffler (2016) shows that the legal framework determines the law of the game in the election by ensuring the right to vote and run for office, and that election is held at regular intervals. The Legal Service Director of the NEBE supports this idea. The advantages of formulating a legal framework for the e-voting system explained by the Legal Service Director as to make e-voting technology compatible with the country's existing laws and principles, to make e-voting system lawful and regulated in the country and to list transparency and security mechanism of e-voting system. E-voting technologies are protected under the law that appears in the legal framework. There is no legal framework for e-voting technology in Ethiopia because no election is conducted through e-voting. In Ethiopian, Political Parties Registration, and Election's Code of Conduct Proclamation noting about the e-voting technology, but in Article 51 number 8l there is an idea about technology, which says the Board might deploy technology to assist with the voting and, following the vote-counting processes. This shall be done in consultation with contesting political parties and the particulars shall be determined by a directive to be issued by the Board. Formulating a legal framework for e-voting technology requires the willingness of the legislative body of the country. The way of extracting legal framework for e-voting technology stated by the Higher Legal Expert of NEBE as when the election board and government want to use e-voting technology as the electoral system, the legislative body of the country extract legal framework for e-voting system and present it to HPR for approval. Based on the grounded framework the election board establishes specific principles and regulations that help to execute legislative structure.

4.5 Chapter Summary

The chapter presents the analysis and discussion of data obtained from the in-depth interview and document review. The challenges of the adoption of the e-voting system are identified. The research pointed out that Ethiopia is not ready to adopt e-voting technology in terms of IT infrastructure, human resources, and legal framework. There is no adequate and secure IT infrastructure and resources in the country, which are adequate for e-voting system implementation. Also, this research indicates that there is no legal protection for e-voting technology in the country. Finally, gaps in human resources and gaps in the IT infrastructure protection mechanism of the country are identified.

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CHAPTER FIVE

CONCLUSIONS AND RECOMMENDATIONS

This final chapter of the research report presents a summary of the findings and conclusions, as well as recommendations and future works based on the evidence presented during the data analysis.

5.1 Summary of findings

Electronic voting is one of the applications of electronic-government that provides several advantages in terms of reducing the problems of the traditional voting system. Therefore, it is important to assess e-voting readiness in terms of ICT infrastructures, human resources, and legal framework. E-voting readiness also requires the readiness in finance, and leadership.

The objective of this study was to identify the gaps in the readiness of Ethiopia for implementing e-voting system from the supply side. And in line with this objective, two research questions were formulated as stated in section 1.3. In dealing with the research questions, a qualitative research method was employed and relevant literature was reviewed. Data were collected using in-depth interviews and document reviews. Thematic analysis was used to analyze the data because it is a more powerful tool when combined with research methods such as interviews, and the use of archival records. The major findings of the study were presented below in the form of answers to the research questions.

The first research question focused on identifying the readiness of Ethiopia to adopt the e-voting system from the supply side. The study revealed that the adoption of e-voting technology is difficult in light of the current state of the country. Participants of this study from the Electoral Board indicated much needs to be done to adopt e-voting technology, such as expanding ICT resources and infrastructure, training adequate human resources, and extracting legal structure for the e-voting system. The willingness of the government to use technology for conducting a free and fair election and experience of e-voting technology from the different nations is the groundwork for the adoption of e-voting technology. The study found that the country is not ready for the e-voting system adoption in ICT resources and infrastructure, human resources, and the legality measure.

The second research question focused on identifying the possible gaps for the successful implementation of the e-voting systems. The study revealed a potential gap in ICT infrastructures, human resources, and the legal framework for e-voting technology implementation. According to the findings of the study, Ethiopia's current ICT resources and infrastructure are not mature enough to implement a nationwide e-voting system. Successful implementation of e-voting technology requires a secure data center, an accessible telecommunications network, Internet connectivity, and voting equipment. The country's current telecommunications infrastructures do not encompass the entire parts. There is no sufficient network and internet in most rural areas of the country. The participant of this study from MInT indicated that the mechanisms used by the government of Ethiopia to protect ICT infrastructures and resources are inadequate. As a result, the country's existing ICT resources and infrastructure are venerable to theft and destruction. There is also a gap in the IT infrastructure of the Ethiopian electoral board. The electoral board did not have a secure data center and internet connectivity to count and store the election data. The study found that there were no qualified staffs' supporting the implementation of the e-voting system in the country. Participants of this study from the Electoral Board indicated that the unavailability of qualified human resources inhibits the implementation of e-voting technology. No expert assesses the environment of the e-voting system in the electoral board. Before implementing e-voting technology continues, training should be given for staff involved in elections. Participants of this study in the Electoral Board revealed that there is a gap in providing technology-related training for employees. However, some employees of the election board went to Belgium, India, and Namibia to take experience in e-voting technologies this indicates that the government and election board have an interest in the e-voting system. The study also found that there is no legal structure for e-voting technology in the country. The study participant from the Electoral Board indicates that there is no legal framework for e-voting technology in Ethiopia; this is because no election is conducted through e-voting. However, in the Proclamation article 51 number 8l, there is an idea about technology, which says the Board may deploy technology to assist with the voting and, following the vote-counting processes.

5.2 Conclusions

The traditional voting system used by the Government of Ethiopia is prone to several problems. E-voting technology is a solution to reduce the problems of the traditional voting system, to update the electoral system of the country, and to make the election results reliable for the public and the opposition parties. Despite the successful implementation of the e-voting system, the assessment of readiness is crucial. The following conclusion was drawn from the above findings and discussion.

E-voting technology uses ICT resources and infrastructures to record, cast, and count votes. Ethiopia's existing ICT resources and infrastructure are inadequate to implement e-voting technology. There were no secure and expandable ICT resources and infrastructures across the country, which is sufficient for nationwide e-voting technology implementation. There is a gap in coordination across the country to protect ICT infrastructures and resources.

Concerning qualified human resources for the successful implementation of the e-voting system, it was found that there were no qualified, knowledgeable, and experienced staff supporting the implementation of the e-voting system. There are no e-voting experts in the country, even though the existing election expert has no depth idea about e-voting technology. Some of the staff of the election board did not hear about e-voting technology, which indicates gaps in providing technology-related training to employees. No written documents were available in the country on the legal structure of e-voting technology. There are no standards, rules, and guidance for e-voting technology.

5.3 Recommendations

Countries that have been used the e-voting system as electoral means reduce the problems of traditional voting. Based on the findings of this research, the researcher recommended that the following measures be taken to improve Ethiopia's readiness for the e-voting system implementation.

- ✓ The National Election Board of Ethiopia should be ready to communicate with the government and another stakeholder to identify the challenges of the adoption of the e-voting system. The management of the electoral board is expected to identify the gaps in e-voting readiness and use their efforts to address these gaps.
- ✓ A great deal of effort is needed to make the country's current ICT infrastructure and resources adequate for the e-voting technology implementation. The government of Ethiopia will engage the private sector in the telecom investment to extend the existing ICT resource and infrastructure.
- ✓ Ethio Telecom and the Ministry of Innovation and Technology should work together to protect the ICT infrastructures and resources of the country. Guidelines should be issued to ensure that governments and public institutions do not interfere with the telecommunications infrastructure when they carried out their tasks.
- ✓ The NEBE should be ready in terms of the ICT infrastructure for implementing the e-voting system. The board should conduct various activities to make the existing IT resources enough for e-voting system implementation.
- ✓ In terms of qualified human resources, a thoughtful effort is required to be ready in the e-voting system implementation. Skillful and experienced human resources are needed to address technical problems that may arise on e-voting hardware and software before, during, and after the election. The election board should assign experts who are responsible for assessing the e-voting system environment.
- ✓ Awareness about e-voting technology should also give for employees of the election board. The board shall deploy several tasks for fulfilling the benefits and wages of employees. The top management staff of the election board should provide continual support and guidance for the employees.
- ✓ Formulating a legal framework for e-voting technology needs the willingness of the legislative body of the country. Preparing a legal framework for the e-voting system is one of the indicators of e-voting readiness. The election board and legislative body of the country should prepare a legal framework for the e-voting system.

- ✓ The legislative body of the country must incorporate the e-voting system into the electoral proclamation. The election board shall also prepare a list of directions and rules that help to execute the e-voting system proclamation.

5.4 Limitation of the Study

Referencing or citing to earlier research studies provide a theoretical foundation for the research context. The lack of previous research studies in e-voting system readiness put a limitation on the relevant literature review of the research.

Although the researcher intended to interview more election experts, legal staff, and IT personnel from the Ethiopian Electoral Board, the election season approaches, time and resource constraints put confinement on the number and selection of interviewees. A larger sample would probably improve the reliability of the study.

Another limitation of the study was the lack of information on the country's IT infrastructure and resources. The refusal of Ethio Telecom would limit the amount of information on IT infrastructure and resources.

5.5 Future Work

This research primarily focuses on identifying the gaps in the readiness of Ethiopia for e-voting system implementation from the supply side. This research is the preliminary research in readiness of the e-voting system in Ethiopia, and it will serve as the keystone for future research in the area. However, the researcher recommends future studies in the following area:

- ✓ Research can be conducted on the factors that affect the implementation of e-voting technology.
- ✓ The readiness of the eligible citizens and political parties to conduct elections through the e-voting system is also requiring comprehensive research.
- ✓ Types of e-voting systems better to engage citizens who living aboard in the election.

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ANNEXS

Annex One

Interview Guide for Election Operation and Logistic Directorate of NEBE

Time interview started_____

Time interview ended_____

Date of interview_____

Name of Institution_____

1. What is your job position?
2. How long have you been within the organization?
3. What types of voting systems does Ethiopia follow? (paper-based or e-voting)
4. In your professional opinion, do you think the current paper-based voting system has problems? Yes/No

   If yes, explain some of the problems:
5. Can you guess the current number of eligible citizens across the country?
6. Can you tell the approximate number of election districts, polling stations that are available in the country?
7. Have you ever heard of the e-voting system? Yes/No

   If yes, what does it mean?
8. Do you think e-voting technology is complex to adopt? Yes/No

   If yes, explain the challenges that affect its adoption:
9. Do you think that e-voting will be affected by the high illiteracy rate, poverty, and inadequate ICT infrastructure?
10. Is there any e-voting initiation in the national election Board?
11. Is there a lack of willingness on the part of the government to use technology to conduct a free and fair election?

12. Do you think it is necessary to implement the e-voting system in the country?
13. Do you believe that the e-voting system provides benefits regarding cost, trust, accessibility, and security?
14. Do you think that e-voting can reduce the voting problems of the country, which was raised in the past elections?

Annex Two

Interview Guide for Government ICT Network Development and Administrative Directorate, and Government Electronic Service Application Development and Administrative Directorate of MInT

1. Do you think the ICT infrastructure of the country affects technological innovation in this case e-voting system?
2. Does the ICT infrastructure of the country can support the implementation of technological innovation e.g. e-government, e-democracy & e-voting?
3. Is there a Scarcity of ICT resources and infrastructure in the country?
4. Do you think that the e-voting system is compatible with existing IT infrastructure and IT resources? Yes/No
5. Is there adequate investment in the IT infrastructure and resources?
6. Can you tell me the Infrastructure that will be needed for e-voting implementation
7. Is there adequate security enforcement to protect ICT facilities throughout the country? Yes/No

   If yes, list some of the security mechanism:
8. Is there a lack of coordination across the country on the handling and proper usage of ICT infrastructures?
9. Do a problem of internet connectivity and bandwidth affect technological innovation implementation in this case e-voting?
10. Do you think that e-voting is one of the applications of e-government?
11. Is there any initiation in your organization to support e-voting system implementation? Yes/No

Annex Three

Interview Guide for IT Directorate of NEBE

1. Do you think the current ICT infrastructures of your organization are enough to implement the e-voting system?

   If your answer is yes, where is it located?

   Tell me the server type and the application used by your organization:

2. Does your organization have power back up for the time of failure of the AC power supply?
3. Is there LAN connectivity in your organization? Yes/No

   If No what type of connectivity does your organization use:

4. Can you tell me the current internet speed of your organization?
5. Are there problems in internet connectivity and bandwidth in your organization? Yes/No

   If yes, explain the major problems:

6. Does your organization have a security mechanism to protect ICT facilities? Yes/No

   If yes, list the security mechanism used by your organization.

7. Do technical and managerial skills in your organization affect the use of technological innovation in this case e-voting system?
8. Is there an unwillingness to change the voting environment regarding ICT Experts? Yes/No

   If yes, explain the reason:

9. Does NEBE have a future development plan for basic ICT infrastructure to implement e-voting systems? Yes/No

   If yes, clear out the plan:

10. Does your organization plan a sufficient budget for facilitating ICT infrastructure?

Annex Four

Interview Guide for Human Resource Directorate of NEBE

1. Do you think that e-voting will be affected by inefficient and inadequate human resources?
2. Does your organization have employee experts who assess the readiness of the e-voting system environment?
3. Is there any department in your organization that organizes pieces of training related to technological innovation in this case e-voting system?

   If your answer is yes, explain the department
4. Do you think employees in your organization have awareness of e-voting technology?
5. Is there a lack of leadership support on the e-voting system in your organization?

   Yes/No

   If Yes what is to be done for improving leadership support
6. Do you think the recognition and reward system of the organization affect technological innovation in this case e-voting?
7. Do you believe that employees with experience in the e-voting system will leave your organization? Yes/No

   If Yes mention the strategy to snatch the employee
8. Are there any factors that affect employees' performance in your organization? Yes/No

   If Yes, explain the factor related to organization, and managerial
9. Is there a lack of supply of government on delivering skillful manpower in the field of

   e-voting technology?
10. Does the government provide finical support for fulfilling different mileage milage of employees?

Annex Five

Interview Guide for the Legal Service Directorate of NEBE

1. Do you think e-voting readiness affected by legality?
2. Does the constitution FDRE influence e-voting system readiness?
3. Is there a regulation related to the e-voting system?
4. Is there any clear and transparent legal framework of the e-voting system? Yes/No

If Yes, explain it:

5. Does the e-voting system exist on the Proclamation? Yes/No

If Yes, mention the proclamation number

If e-voting exists on proclamation, Does there conflict between national standards with international standards on Proclamation about e-voting?

6. Is there a lack of commitment to the legislative body of the government to form a legal framework for the e-voting system?
7. Does there a lack of commitment of election legislation to published e-voting principles and regulations and made readily available for the intended peoples?
8. Do you believe in the necessity of extracting the legal framework for the e-voting system? Yes/No

If Yes list some necessity:

9. Do you believe in the appertain of notifying the e-voting system for the country legislation body? Yes/ No

If No, explain the reason: